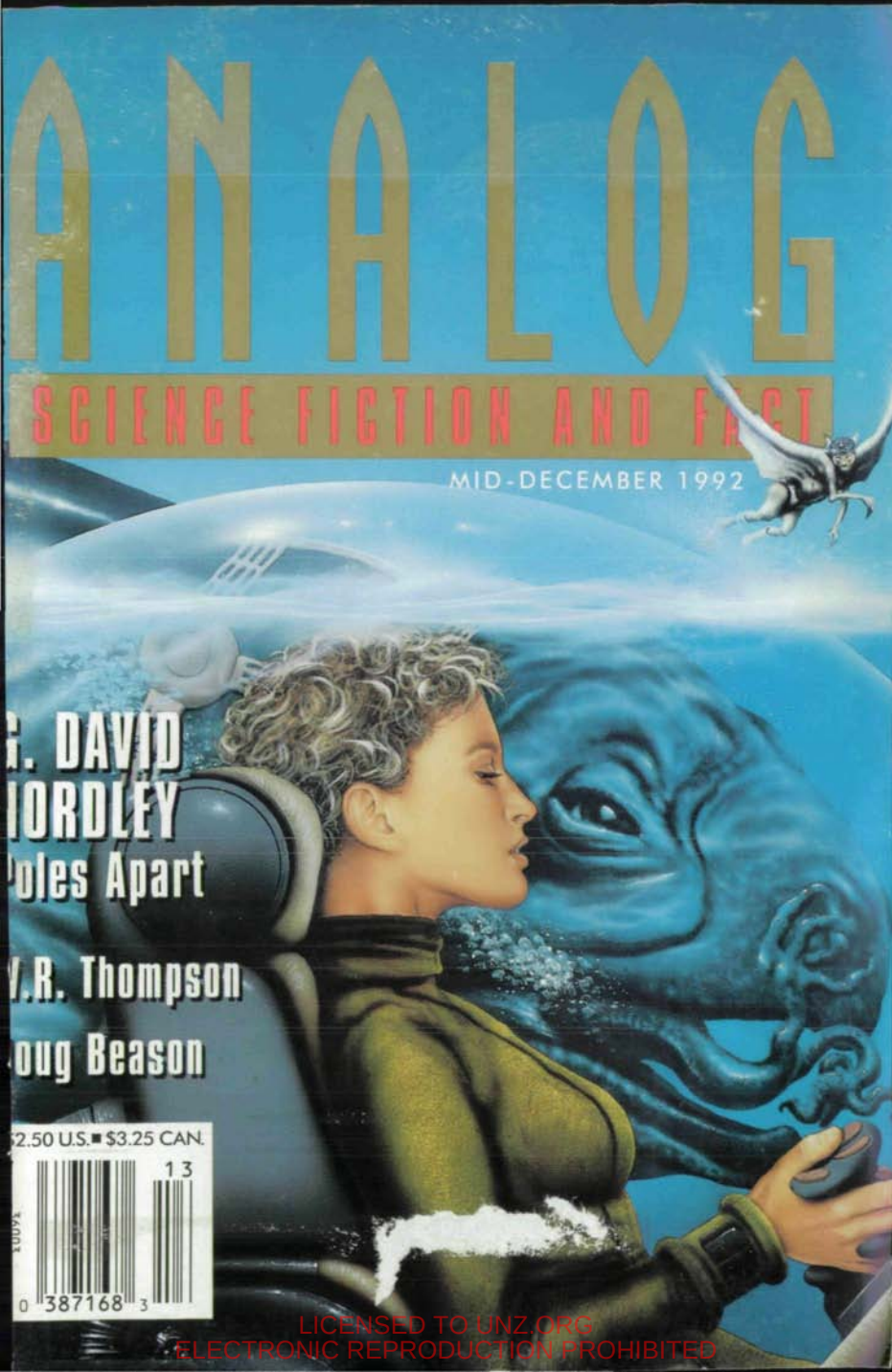

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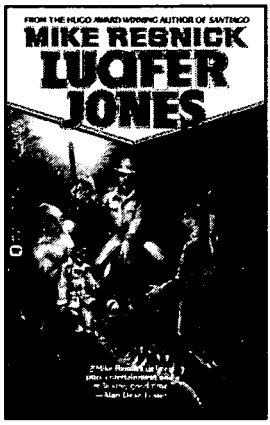

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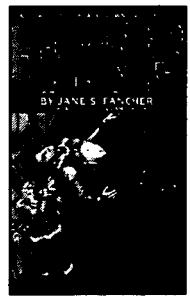

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EDITORIAL Stanley Schmidt

BEYOND THEM AND US

One of the more bizarre results of the collapse of Communism is the proliferation of thinking like that summed up in a recent headline: "After Cold War, who will wear the black hat?"

The Associated Press article went on to explain that, according to "foreign policy experts," "... the United States is looking for another adversary—of whatever kind—in order to rally support ... behind the Stars and Stripes." The article spoke quite seriously of the need for a "villain" to oppose, and the idea that such unsavory individuals as Moammar Ghadafi or Saddam Hussein are only partly satisfactory in that role because they're too ephemeral. It quoted a psychoanalytic anthropologist as saying, "We've had a hard time finding an enemy to glom onto."

Now let me get this straight. Finally freed of a force we've felt threatened by for decades, we're complaining about how hard it is to find a new one?

Talk about looking for trouble. This gives new meaning to the phrase!

What astonishes and disturbs me most in all this, I think, is that lots of people are saying such things, and nobody appears to question whether they make any sense. It seems to be generally accepted as gospel that We Gotta Have Someone to Hate. "For there to be 'us and them' is human nature," we're told. It comes with "man's innate tribalism and need for conflict."

It seems to me that a time when we're "between enemies" would be an excellent opportunity to re-examine and question assumptions like that, rather than frantically rushing to find new targets on which to apply them in tired old ways. Just what *is* human nature? How do we know? How sure are we? How "innate" are tribalism and a need for conflict?

I offer a truly radical suggestion. Maybe in the wake of the Cold War, instead of looking for somebody new to hang a black hat on, we should be seeing whether we can use the opportunity to outgrow the *need* for a black hat on somebody else! The question of exactly what human nature is is extremely important and exceedingly difficult to answer unequivocally. Most laymen (and too many scientists), regardless of what culture they live in, tend to assume

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that human nature includes a great many things which are actually peculiar to their own cultures. Those who take the trouble to study some cultural anthropology, to learn of the real diversity of human cultures, past and present, acquire a somewhat broader view. Ruth Benedict, for example, in *Patterns of Culture*, contrasted our culture's view of peace and war with those of several other societies. We see an alternation of peace and war as a normal cycle, but Benedict described other cultures who had no concept of peace and still others who had none of war.

So when we are told that humankind has an "innate" tribalism and need for conflict, how much of that is universal truth and how much is interpretation colored by the culture and personal experience of the interpreter?

Point one: "innate" implies "built-in" or "preprogrammed." The roots of the word mean, quite literally, "in-born." Point two: might a trait be innate in some individuals but not others?

My personal observations indicate that there is wide variation in the extent to which individuals have this tribalism and need for conflict. Certainly it's very widespread, in our culture and many others. But is it a universal human characteristic? I know a number of individuals who show little or no sign of it.

Cynics with the preconceived notion that it's an inborn drive in all humans would say this merely proves that they've suppressed its outward manifestation, not that they don't have it. This may or may not be true. It's pretty clear that the way we behave is shaped in part by the equipment we inherit, and in part by what we learn to do with it. People have been arguing for a long time about the relative importance of those two categories of influences, but it's so hard to isolate either of them that nobody has any definitive answers.

It's also possible to turn the cynics' guess around. If people are desperately seeking new villains, might not the reason be, at least in part, that they have been *conditioned* to think in such terms? Maybe they don't have an *inborn* need to pick some outsider to hate, but their cultures have become so accustomed to *teaching* their young to do so that they don't know any other way to approach the world.

In either case, is it not just conceivable that teaching and conditioning might be used to create a *better* way

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of thinking and living? If hating as an end in itself is primarily a result of cultural conditioning, a different kind of cultural conditioning might eradicate it. If it is an inborn tendency, but some individuals have learned to suppress it and live comfortably without it, a different kind of cultural conditioning might enable more individuals to do so. If that happened to enough individuals, it might lead to a very different kind of world.

I can hear the objections of those who have been conditioned to believe that we must not suppress feelings or urges. I reply that the very essence of civilization consists largely of learning to do so in ways that are not self-destructive. It *can* be done: we have all learned to do quite a bit of it, and if civilization is to survive, we shall have to learn to do still more. Most of us have learned, for example, to suppress the urge to kill everyone who crosses us, and we quite rightly do not tolerate individuals who haven't. We are in the process of learning not to reproduce every time the urge strikes, and our future viability depends on how well that lesson continues to be learned.

We like to think of ourselves as an intelligent species; it's reflected in our taxonomists' name for ourselves, *Homo sapiens*. A key part of the job description for an intelligent species is that its actions are determined largely by experience and reason rather than by simple genetic programming, more commonly known as instinct.

Many animals do act largely on that basis, making a fixed response to a simple stimulus without thinking

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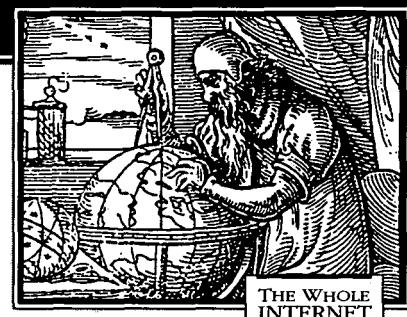

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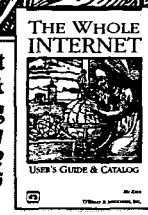

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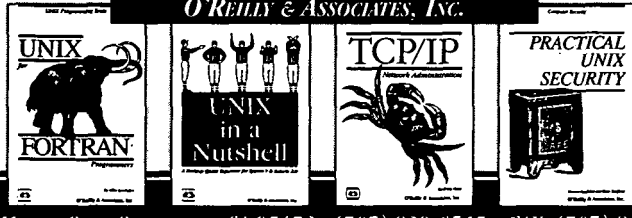

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about why they're doing it. Snakes, for example, are self-sufficient from the moment of hatching. They don't do a great variety of things, but they come equipped with fully operational knowledge of exactly how to do the few things they must. Instinctive responses are not necessarily extremely simple. Some species of birds, for instance, build quite elaborate nests whenever the appropriate season rolls around. They don't have to be taught, yet every member of the species builds the same kind of nest.

That's instinct. The more intelligent a species is, the less its behavior is determined that way. Humans have very little true instinct left; we've traded it in for a long childhood spent learning facts and methods. We do probably retain vestiges of instincts, which some call "drives." These may predispose us to consider certain kinds of actions, or even impel us to take them when we don't have the time or interest to think about whether they're the best course. There is room for doubt about the strength of those predispositions and the extent to which they can be modified by conscious thought.

But there is plenty of evidence that they can be modified to at least some extent. There are also good reasons to suspect that our alleged "innate tribalism and need for conflict" are in the "drive" category. That is, at least some of us may well have a built-in propensity for hanging a black hat on one or more of our neighbors—but that propensity is subject to modification by cultural forces. And such modification can mean either strengthening or weakening.

Most of us have been subjected to lots of attempts at strengthening the "us-versus-them" drive, from innocuous-looking pep rallies in schools to the mass brainwashing of the late Communist regime of eastern Europe. We know those work. Given the chance, might it not be a good idea to see how effectively we can *weaken* that drive?

Such an effort would, of course, have to be made with some caution. The idea that we should *never* hate or fear anyone else is as potentially dangerous as the idea that we must *always* hate or fear someone else. We need never lose sight of the fact that others *can* be dangerous to us, and need to remember how to do something about it when it happens. But is it really necessary to practice constantly on *somebody*, even when there doesn't happen to be anybody who truly deserves hate or fear? If we are *really* an intelligent species, we should be able to do better than that. We should be able to respond appropriately when we are genuinely threatened, and to avoid responding inappropriately when we are not.

If we are indeed at a time when we no longer have a super-villain to fear as we have done for several decades, let's not demean ourselves by squandering the opportunity looking for somebody else to hate for hate's sake. I propose a bolder experiment: let's inculcate the idea that man, because of his intelligence, can *choose* the direction he wants to evolve in, and that this is an opportunity to embark on a better one.

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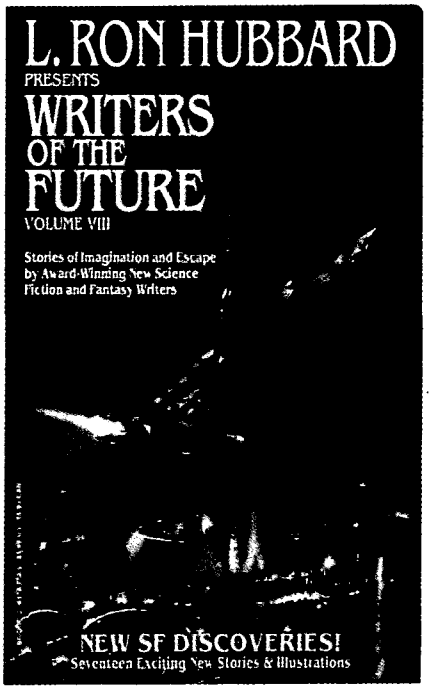

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Of course, it *is* a radical suggestion and a formidable challenge. It involves getting large numbers of people to think rationally and to act on the basis of reasoned thought rather than raw feeling—and that is a *big* order. As Professor Henry Higgins asked in *My Fair Lady* and might well ask again upon reading any newspaper, "Why is logic never even tried?" A look at either the Rodney King case or the riots that followed in the spring of '92 is a good illustration of how seldom it is—but then, has anybody really tried teaching it in a serious, determined way and on a large scale? We *have* been taught a lot of nonsense about how much better feeling is than thinking; maybe it's time to try for a more balanced outlook.

As a character of mine once observed. "The value of intelligence is that it can overrule instinct when instinct is wrong." Let's see whether we can act as if we believed that.

There's no time like the present to try. ■

●A teacher affects eternity; he can never tell where his influence stops.

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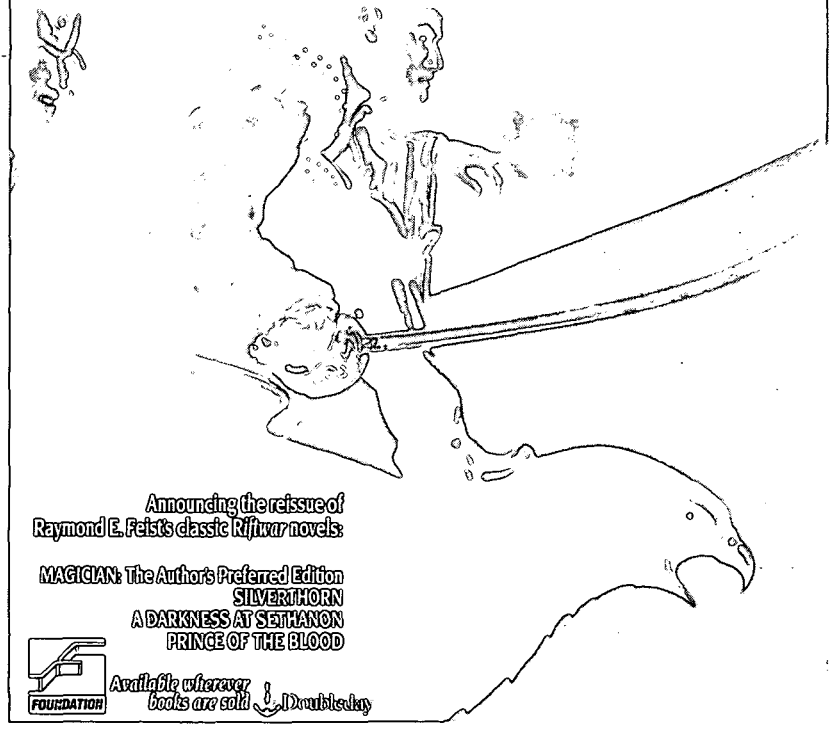

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Mid-December is our last issue for 1992, and as usual we're asking you to help us via The Analytical Laboratory. Not only will your votes provide tangible rewards for your favorite authors and artist, but your feedback will help guide our selections of what to offer you in the future. Your vote is important!

Look over all your copies of *Analog* dated 1992, or refer to the annual Index which will appear in our January 1993 issue. Pick your *three* favorites in each of the following categories: novella or novelette (a single category, for AnLab purposes), short story, science fact article, and cover. If you're not sure about a piece's category, you'll find it listed in the Table of Contents for the issue in which it appeared, as well as in the Index.

List your choices in order of preference (your favorite in each category is #1) on the ballot below, and mail it in. The ballot is intended to make it easier for you to vote, but if you don't want to cut it out, feel free to copy it. We'll tabulate the votes and let you know how they came out.

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To be sure your vote counts, please mail it in time to reach us by February 1, 1993.
Thank you very much!

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POLES APART

G. David Nordley

Primus was a noble experiment
on a grand scale—but
when your test tube is a world,
it's hard to control
every part of it.

Illustration by Alan M. Clark

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. . . to establish a single planetary society in which all three spacefaring races take equal part: to find and develop common standards of civilized behavior, which may serve as a model for galactic civilizations to come.

—Compact and Charter of the Planet Trimus, Preamble

The human ship, almost four Charter units long with a huge square cloth sail, was new to Lieutenant Drinnil'ib. What, he wondered, were primitivists doing this far north? He hailed the ship, but instead of a verbal response, his voice brought a scurrying of the small two-legged beings around its deck. Before he could repeat the hail, a sharp, explosive, report split the air and something with a singing line attached went "thwunk" into the sea beside him.

What in the name of the Compact? he thought. The line brushed over his nose and he stuck his tongue out to grab and examine it. The line came under tension, and he let it slide through his manipulators until the end came along.

Pollution! The thing was sharp. It nicked the muscular fingers on one fork of his tongue before he clamped down on the line with the other, forcing the humans to try to reel him in with it. That should slow things down a bit, he thought. He raised a front claw and wrapped the line around it to ease the strain on his tongue. Then he held the object in front of his eyes. It was solid metal of some sort, and barbed: something that could have killed him if it had hit him in the wrong spot.

The thought and his reaction were almost simultaneous; he snapped his tail and bent his body downward. Not an eighth of a heartbeat later a tinny pop reached him through the water and another of the things zapped by. They *were* trying to kill him!

He let go, pulled a knife from his pouch, and slashed the line between the barbed missile and his foot. Then he swam first toward and then away from the ship, holding the line with his foot, and felt a satisfying give in the line after it jerked taut. He had some momentary misgivings—humans were fragile and he might have hurt one. But perhaps not: the tension on the line resumed quickly. Another slash of the knife took care of that. Drinnil'ib shook the remains of the rope from his claw, dove beneath the ship, and kept pace just below its hull.

Reaching back to his pouch, he replaced the knife with his gun and contemplated the plank belly of the offending vessel. Two, he thought, could play perforation. It took ten explosive rounds to put a fair-sized hole in the hull; the layers of polluting timbers were a twelfth of a Charter unit thick. But when he was finished, the ship was leaking so badly it would have to head for port too quickly to bother any other Do'utian.

Satisfied, he breached the surface immediately behind the ship, fired

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a shot in the air and roared a challenge: "I am planetary monitor Lieutenant Drinnil'ib and you have just assaulted me. What in the name of eternal repudiation do you think you are doing?"

Shouts sounded and sails rose. He grabbed the rudder of the ship with his front foot and wiggled it vigorously. Finally a face surrounded by reddish hair appeared over the railing on the rear of the boat.

"What in hell are you doing here, Monitor?" it shouted at him. "This is primitive territory—you damn techs are supposed to leave us alone."

"Not when people start getting killed," Drinnil'ib replied in a more conversational tone. "You can play your games but you have to observe the limits."

"Don't screw around in what you techs can't understand," it yelled. "Just leave us alone!"

Drinnil'ib rocked the ship again. "You're going to sink right here if you don't acknowledge that you can't sail around shooting people, wherever you are. It's against the Compact."

"All right, all right, I hear you. Shooting at you was a big mistake. But next time, stay out of human whaling waters, Fish-man."

The polluting idiot didn't seem to show a trace of remorse, however Drinnil'ib thought he might be misinterpreting their body language. Just to be sure they didn't misinterpret *his*, Drinnil'ib gave the harpoonists something very easy to understand: he emptied his lungs of moisture-filled air right at them, soaking the speaker and sails. Then he kicked the ship away in disgust and sounded. Ten Charter units deep Drin put the barb in an evidence wrap, exchanged his gun for his communicator, and filed his report. He'd just gotten an object lesson on how some of the killings might have happened, but he would need human help to get to the bottom of it. A good excuse to look up an old colleague. With measured beats of his muscular tail, he headed for the northern reaches of the western continent.

As the tide-locked satellite of a superjovian infrared primary, Trimus has three symmetry axes: north-south, east-west, and inner-outer. This gives it three sets of geographic poles and three distinct climatic regions that allow for all three species to live in comfort. The arctic and antarctic match similar regions on Do'utia. The cool region surrounding the far pole matches the climate of the most populated areas of Kleth. The Earth-like near hemisphere is warmed both by Aurum and Ember, and ranges from temperate near the east and west poles to tropical directly beneath Ember. Trimus's close orbit about Ember gives it an effective day which is about twice the day of the Kleth homeworld, one and a half times that of Earth, and three times that of Do'utia. For the last, however, what counts is the 407-day polar season cycle produced by the half-radian inclination

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of Trimus's orbit to the local ecliptic, and this is almost the same as on Do'utia.

—Planet Monitor's Handbook, Introduction

The morning sun was a tiny red ball in the mists next to the great ruddy crescent of Ember, as Drinnil'ib propelled himself upstream toward the human city with powerful tail strokes. The murders, he thought, struck at the purpose of Trimunian civilization by pitting one species against another.

Trimus was supposed to be the galactic laboratory for peaceful interspecies cooperation. But Ember had circled Aurum eight-cubed times since its settlement, and only the collective memory of the Kleth and the mechanical memories of the Humans went back that far. Some, he knew, felt this purpose had faded along with the need for experiment; preempted by distances of time and space so great that the residents of Trimus no longer represented the cultures that sent them. If they ever had, he thought wryly. Beings who would leave their home worlds forever to take part in an idealistic interstellar experiment may have had more in common with each other than with their various contemporaries.

But as far as Drin was concerned, the millennial-old civilization of Trimus had become its own reason for existence. Forget the rest of the galaxy and their occasional starships: to survive in peace with each other and their planet, its residents had to put the discipline of reason ahead of the natural inclination to group things by shape. To be a monitor was a calling, and he had no greater loyalty than to his world and its ideals, except, perhaps, to reason itself.

Headquarters said that Mary Pierce would be waiting for him at the marina landing past the watchtower at the base of the main channel bar, wherever that was... there! He caught the echo and eased himself to the right and into the deep cool channel. The harbor bottom was a backwater fairyland of human bubbles and Earth-life reefs, and the channel led through that like a wide black road. At its end, the cigar shapes of human submarines lay in a neat row, safe on the bottom from the winter ice. He put his legs down, released a bubble to settle himself firmly on the concrete, and with even measured strides hoisted his body into the warm air of the eastern continent.

A tiny tailless being, much smaller than the arrogant, hairy-faced barbarian that had cursed him earlier, waited for him at the end of the ramp, covered with a form-hugging cloth that Drinnil'ib knew was an even better insulator than his doci-thick blubber.

"Afternoon, Drin?" it called, the high pitch indicating it was a human female.

"Greetings," he rumbled and reached forward with one of the branches of his tongue to shake her hand. The familiar taste of the air around her put him at ease. "Mary?

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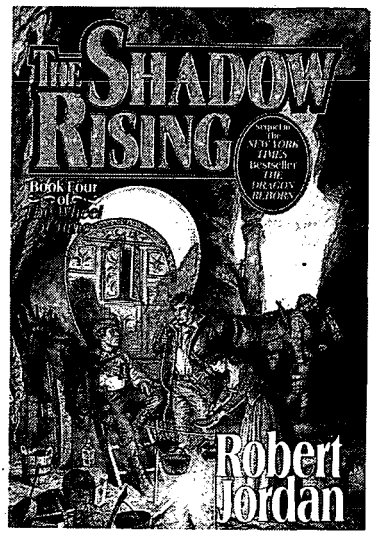

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I'm sorry but it must be eight years since we last met. It's really good to see you again."

Now that he knew it was her, it was easy to pick out the subtle individual characteristics of her almost-naked simian face and match them to his memory; the slight bend in the cartilaginous growth that housed her nostrils, the upturned angle of the hair on the upper ridge of her eye sockets, and its yellow-white color framing her face. It was a clean face, unmarred by any unnatural growth or scar, and he knew other humans considered her beautiful. He would agree, judging from the esthetics of functionality, and also from the esthetics of the curve.

"You look pretty magnificent yourself, chum," she responded, but then shook her head. "I only wish the occasion was a happier one."

He bobbed his massive head in the planetary convention of assent. "Five more dead, four Do'utian and one human."

"Butchered?"

"Neatly, intelligently, as last time, except the human. The sea left too little of him to tell. But this," he held up the barbed projectile, "may be at the bottom of it."

"Primitivist hunters?"

Drinnil'ib hooted. "Not primitive enough, it seems. This was propelled by chemical explosives."

There were always some from every species, from every generation, romantics who wanted to live in the reserved areas by their instincts without having to learn the science and culture that got their ancestors to Trimus. A disease of the character, he thought, which could not be eliminated without eliminating character itself.

"I am sorry, Drin," Mary said, "for what our children have done. They form communities, the communities evolve, get recruits, and no one seems to care. Some of those places haven't been visited in a century."

Drin gave a sigh of toleration. "It is in your nature to hunt and in ours to endure the hazards of the sea. But without a trained intellect to guide, any race . . ."

She shook her tiny head in negation. "Some things are *wrong*, and always have been. Everywhere for everyone. Killing is one. They know the Compact, that's a minimum for letting them go out there. So it's up to us to find which 'they' are responsible and take corrective action." She shrugged her shoulders and spread her arms. "A policeman's lot is not a happy one."

A quote he didn't recognize, but one that fit. Lieutenant Drin bobbed his head again.

"Oh, the duty can be interesting."

"Ha! Well, my sub's ready to go; we can leave any time," she said. "But I thought you might like to try Cragen's sushi before we head out." She bared the exquisite miniature ivory chisels of her teeth to him in a human gesture of good feeling. Was there, he wondered, some art in this reminder that both of them were occasional carnivores? He

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would have to ask her on the journey. Meanwhile, the sushi sounded most pleasant. He hoped they could find a cubic doci of their rice wine to go with it. About one of their traditional "gallons," if he recalled: "And a, um, gallon or two of, um, sake? To go with it?"

She laughed "Just what I was thinking, Drin. Let's go."

Glensville, on the northing Graham River, was easily cool enough in winter to be a congenial tropical vacation spot. He just had to remember to move slowly to avoid building up too much body heat. Great banks of melting snow lined the road, and ice covered the dozen park lakes scattered among the stone and wood human hives. Cheerful humans sliding on long flat boards attached to their feet waved to him as he ambled down the main road with Mary.

Cragen's was one of the few above-water taverns on the eastern continent that was set up to serve Do'utians. There were two there when he arrived with Mary: the poet Shari'inadel and a large Do'utian man with fresh white scars on his flukes and a deep, raw crescent behind his blowhole. Those were unusual wounds for this area—the sort of wound that one got in a beak fight with another Do'utian. So, Drin thought, this Do'utian must be primitivist of sorts—the kind that got his jollies on the southern beaches and came back every now and then to partake of the benefits of civilization.

The other turned its head, saw him, and hissed. Most impolite, and for what reason? Drin's lack of scars? His civilized bearing? His human companion? But this was a human town!

"I do not know you," Drin stated formally. "I am Monitor Lieutenant Drinnil'ib and I ask respect."

"Gota'lannshk. The sea has been generous with you, pretty monitor. But don't press your luck, beachmeat." The voice was a slurring, low pitched rumble.

Drunk. Spoiling for a fight. Drin gave the other a sharp warning hiss, then turned away to ignore the reaction and cool his own rising irritation. He heard no response.

"You don't like him, do you?" Mary whispered.

"I've never met the man," Drin replied, beak shut, letting the words escape softly through the fleshy corner of his mouth. "But what he is does not swim well in my thoughts. His companion is a poet, named Shari. I know the family—she's their first egg in two centuries, and quite indulged. She could be just the sort of dissatisfied romantic that runs off for glandular adventures in the south, and then lives to regret it. I think she is being 'offered' a place in that ogre's harem."

"Her choice, isn't it?" Mary asked.

"Choice implies an intellectual process, but he's playing on her instincts. Look at that one, and do not judge human rustics so harshly. He appears to have engaged in mortal combat for the fun of it."

Mary coughed. "Drin, Cragen's

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has some giant squid fresh from the farm. I'll split it with you, 999 parts to you, 1 to me."

"Can you eat that much?" Drin rumbled. After his journey, a meal ashore would be welcome.

"Try me!"

"You're on." Drin made the order. "Someday I'd like to try this squid in its native ocean, though." A fantasy of his; when would he ever find time in his life for a round trip of ninety years?

"That's where you'd have to eat it. You're too fat to walk around on Earth." She had a point. Twice the gravity of Trimus would have disadvantages, and he had been gaining a bit lately. Well, he'd swim that off on this trip.

"Maybe you underestimate me," he rumbled. Cragen's did not, however. The squid arrived—more than enough for even his appetite.

They talked strategy. The nearest concentration of humans who might know something lived on the islands near the warm inner pole. Whether or not these folk pinpointed the murderers, Drin made clear that he would need to talk to the Do'utian exiles near the south pole; to placate, to gather evidence, or both. Then would come the older human communities on the southern edge of the undeveloped West Continent.

"Cities of stone, ships of wood. Reports of warfare and slavery." Mary shook her head. "At the very least, they need to be reminded of the Compact."

"That was certainly my experience," Drin agreed.

A common civilization requires a common language, common measurements, and places where all three species can meet comfortably. Human English shall be the common language because it is the only language all three races can pronounce acceptably. Numbers and measurements shall be in the Kleth octal system, which is easiest to learn, is compatible with cybernetic binary systems, and is more widespread than human base ten or Do'utian base twelve. Common architecture will follow Do'utian proportions, so that Do'utians will not be excluded from the social interaction needed for a common civilization.

—The Compact and Charter of Planet Trimus, Article 6

The "Charter unit" is identical to the Kleth "glide," precisely eight to the eighth times the wavelength of the strongest line of neutral sodium (also approximately the peak wavelength of Aurum's spectrum). This is about a traditional Do'utian "tail," once related to the length of the average Do'utian, or almost ten human "meters," once defined as 1/23,420 (1/10,000, base 10) the distance from the equator of Earth to its north pole. The common "doci" (from duo-octi) is $1/8^2$ of this, about the size of the adult hand of any of the three races.

—Planet Monitor's Handbook, Appendix C

* * *

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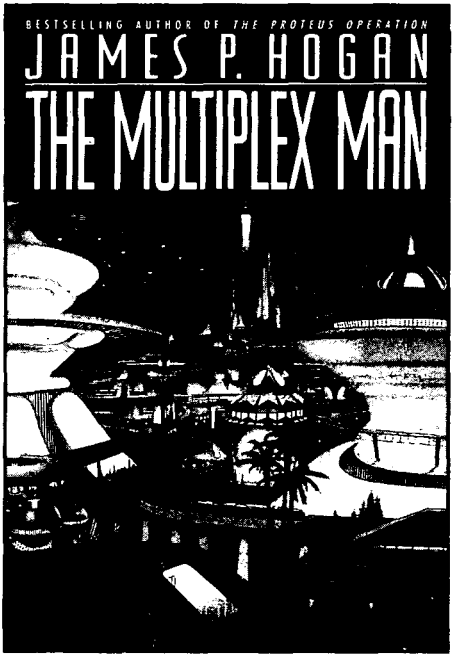
"SUPPOSE THAT ONE MORNING NOBODY RECOGNIZED YOU AND THE PERSON YOU THOUGHT YOU WERE TURNED OUT TO BE DEAD..."

Jean Hogan



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The journey to the inner pole archipelago left Drin fit and trim, and he enjoyed the taste of the exotic tropical fish. But to reach the island, they left the cold south-flowing bottom current and he felt like he was gliding through a hot bath. He looked forward to the south polar waters, and sent an almost joyful greeting to Mary when he caught the wake-sound of her submarine returning from her inquiries.

Nominally, the archipelago would have been reserved for Kleth primitivists, but they were very few and needed little land, so warm-loving human refugees from technological civilization had gradually spread among the islands. Here, near the inner pole, the infrared radiation from Ember came in almost directly overhead, almost doubling the distant orange sun's modest daily contribution. The more or less permanent high pressure system kept skies clear unless the night fog rolled in. But it was clear tonight, and the gibbous, pink-belted almost-star dominated the zenith.

"Were there any witnesses?" Drin asked as Mary came alongside. She was lounging on the deck behind the submarine's pilot house, and the last rays of setting Aurum painted her a rich gold. She had no need for her insulating garment, and he watched muscles play under her thin epidermis as she got up to greet him. A strange shape, yet one that fit its owner as well as any in nature.

"No witnesses—not really that many people around. I found one man who heard about some whalers and got him to tell me he's seen them even in tropical waters. Says they're operating out of a city on a half-flooded volcanic island off the southern edge of the West Continent reserve. I checked the recon and there *is* some sort of primitive city there. Hasn't been visited by monitors for years."

"Were the people forthcoming?"

She shook her head. "There aren't many people here, and those who are here act frightened. I had to offer, well, an incentive to the only person who admitted knowing anything."

"I'm surprised the area isn't more heavily populated. This must be close to the original human climate, you don't seem to need artificial insulation here."

"No, we don't. And it does feel good!" She shook herself and her flesh rippled in a way that reminded him of a jellyfish, but much faster. "But it's enervating. Most people's minds need more stimulation from their environment. The people who live here don't even ask to replace the occasional death—children are too much work. They just live for pleasure."

Ages ago, Drin remembered, humans had arranged their genes to be infertile without deliberate medical intervention as a population control measure to go along with anti-aging measures. The idea of being constantly driven to act out the reproduction process horrified him, but humans apparently

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enjoyed it. Of course it wasn't as messy with them.

Mary shook herself again. "Cooling off now, though. Time to kiss lotus land good-bye."

She waved and vanished down the submarine's hatch. They sounded together and slanted west toward the cold current and their joint adventure.

Half a day later his dorsal ganglia were running things while he was deep in thought about just how primitive things could get. He understood much of the attraction of the undeveloped areas. All space-faring people were descendants of those for whom the unbuilt beach and the untrod planet exerted an irresistible call. But his last trip had been eye-opening in other ways.

He had little basis for comparing what he'd seen to the depth of cultural degeneration Mary said she had experienced on her hothouse island, but all the same, he shuddered to think of what she would find on the shores of the south polar continent. At least humans without machines could still construct buildings. Ancient Do'utian women had mated and calved on the open beach. Without shelter, their retrogressing descendents would have no choice but to do the same. Despite himself, a shudder of prurient interest ran from his chest through his tail at the thought of beaches of nubile young mothers, blatantly receptive in the free air.

"Lieutenant Drin?" Daydreaming! How long had Mary been calling him?

With the flick of the tail, he glided over to the submarine and brought his right eye up to the center of the diamond hull. Its electric drive fields made him tingle as they pushed seawater toward its tail.

"Lost in thought, I'm afraid. What do you have?"

Mary was back in her artificial skin and all business. "Here's the recon on that primitive city." A relief map appeared on the holoscreen next to her. The flooded caldera surrounded a lagoon on three sides, and the forth appeared to be filled in by a simple stone dike. Large and small masonry buildings lined the shore of the lagoon.

"Mary, I think the cold current must flow by there, see the trench to the south?"

"Yes. Good eating?"

"It should be, and if so, we should find some Do'utian primitives nearby. I suggest we stay with the plan, head south first and gain what intelligence we can from the victim population before confronting this set of potential perpetrators.... Mary?"

"Yes, Drin?"

"In our early days, there were tests for reproductive rights. Death swims and beach fights. Bloodlust beyond reason. These occasional hunting deaths seem, in a way, like some of those old tests. I fear I will not be proud of how some of the Do'utian back-to-nature crowd might be living."

"Do you fear more than embarrassment?"

Yes, he needed to say. Yes I fear

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my own primitive instincts. So why did he hesitate to tell her? Mary was a friend and colleague, and any infirmity on his part could affect the mission.

"Mary . . . we have never needed to revise our mating instincts. In our cities, with the privacy of our rooms, there is no need. In fact, we must make an effort to replace those of our colony who are lost by accident—an embarrassing and very private effort for both beings concerned. But with everything out in the open . . . I'm not sure how I will—"

Peals of musical laughter twinkled like bells from the hull of her ship, for so long that Drin became concerned for her health. Finally, she pressed herself to the transparent hull.

"Drin, my friend . . . look, don't tell what I'm going to tell you to any other human, especially the other monitors, OK?"

"My word on it," Drin said, curiosity clawing at him.

"Well," she laughed, "in order to be accepted and get information I kind of went native. I allowed—hell, Drin, I enticed—my source to perform our mating act with me. I mean I was all there, and he was all there, and it just felt like the natural thing to do. In the line of duty, I told myself."

Drin swam in silence for a while thinking that to say the wrong thing would be harmful to his friend. But he soon realized that to say nothing at all could seem even worse. He reviewed what he knew of human mating. "Was this person physically suitable?"

This occasioned more laughter. "He was. Oh, yes. Exceedingly so."

"And you left this pleasure to return to your duty with me? I find this very admirable and hope, to the extent that we can compare our temptations, that I shall be able to exhibit similar moral strength."

"Moral strength? Drin, you are a forked-tongued devil."

After a moment, he realized this was a compliment. He gently pressed a shoulder to the window so that only the eighth of a doci or so of diamond hull separated their bodies. He easily felt the warmth of her flesh through this transparent, uninsulated section. This communication of friendship had no intellectual hazards.

But his mind returned to duty. "Perhaps," he rumbled after a while, "we should ask the Kleth Monitors for backup in case we find we need eyes overhead when we visit this city. I know a certain Officer Do Tor who has a sense of humor and does not dump everything into their racial memory."

"Perhaps," Mary laughed again. "I think I met him when the last starship visited, six years ago. Gold wings, silver crest? Flighty little yellow thing under his claw?"

"The very one."

"Why not? The more the merrier."

Following planetary engineering, only the north, east, and outer poles will be intensively settled.

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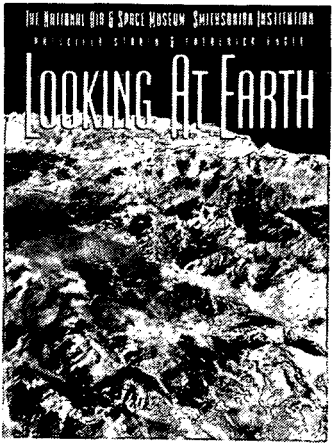

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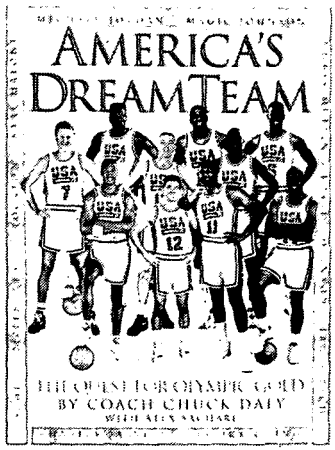

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The remainder of the planet will be reserved for biological study and kept free of large settlements or significant technological effluents. The primary objective will be to observe how the three merged ecosystems evolve from their original design point. Low intensity visitation, consistent with these objectives, may be tolerated by those who wish to experience life in the wild.

—The Compact and Charter of Planet Trimus, Article 12

"I have never seen such a cold, desolate wasteland of rocks in my life," Mary remarked as they approached an outrageously voluptuous antarctic beach. A fish for every taste, Drin thought.

She had parked the submarine and rode on his neck toward the shoreline, her warm thighs smooth against his sandy outer skin. The idea that she often had eggs, of a sort, waiting in a part of her body so near to him gave him ridiculous and perverted thoughts—thoughts that unwontedly stimulated certain secretory organs below the tips of his fingers. Some, he had heard, had experimented with interspecies stimulation and considered it a form of art. Thank providence, he thought, that such thoughts on his part could remain private. But if Mary ever said that *she* wanted . . . No, *no*. Consign that idea to the abyss. Too much chance of giving offense.

It didn't help at all, as they neared the beach, that he could see at least four unabashedly pregnant young Do'utian women lolling thick-necked on the smooth pebbles in the sun. The beachmaster was nowhere to be seen, a circumstance that ran his biological thermometer well past its set point. He wondered if Mary understood how hard this would be for him?

"That beach is an indolent paradise for us, I'm afraid. I'd much rather talk to the head man than that naked harem, but he's left them unprotected. This isn't good. Uh, Mary, if they become aggressive with me, it might be best if I just let nature . . ."

She patted the top of his head, firmly enough for him to notice.

"I'll never say a thing. Promise." She put her arms around his neck, as far as they would go, and pressed the soft parts of her body against the back of his head, laughing. It was not at all unpleasant. Then, suddenly, she stopped.

"Drin," she spoke quickly, "to your left. What is that in the —DRIN!"

Instantly, he rolled his eyes around and slipped his tongue into his pouch, triggering his sonar with one manipulator and grabbing his weapon with the other. Then he saw, and knew instantly that it was too late to do anything.

A tall pole, perhaps half a Charter unit high, supported a white pennant at its end, snapping in the offshore breeze. The other end was firmly buried in the side of the corpse of a Do'utian man, bloated, floating in the swell. He shuddered

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as the wind shifted and brought the scent of death to him.

"Are you OK?" asked Mary.

"Yes. But I would prefer to approach this upwind. How are you?"

She was a trained monitor, and, he hoped, not as affected due to the difference in species. Fortunately for him, the wind shifted again.

"I'm fine. Look, why don't I check out the victim and the murder weapon while you interview?"

It made sense, but he was hoping for her presence to bolster his resolve not to be swept away by instinct on the beach. He belched in self-disgust; was he not master of himself?

"Very well, Mary. I'll take you over to it, I need to get closer anyway. I suspect the victim was the beachmaster here, and if so, these women have been widowed. I should be able to tell from his scent—he will have marked them. Widowing can be a very painful death sentence in primitive circumstances, an unbirthed egg turns poisonous in a month or so."

"So my human primitives kill five Do'utians with one harpoon?"

"Mary, they are not *your* primitives," he rumbled. "Don't take so much on yourself. It's not very professional." He extended his tongue behind him and placed manipulators on both her shoulders. "Besides, there are no reports of harems dying because of the other murders." The thought struck him: why not? "We don't know the whole story," he finished. No, indeed.

He felt her five thin bony fingers cover his three thick muscular ones. She grasped tightly, and he could feel some warmth, though not taste her skin, through her water suit. He could not fathom what feelings ran through that alien mind nor what awful images from her past this fresh corpse might conjure. But he could recognize sadness in her, and try to give sympathy.

His own feelings were proving harder to manage. There was a primal urge in his species to avoid their dead, and thus, the evolutionists believed, avoid whatever circumstances might have led to death. Then there was what waited for him on the beach. He shuddered.

"I can tell you'd rather not go any closer, Drin," A splash surprised him, and Mary swam in front of his left eye. Humans, in general, were clumsy in the water. But they were fearless and some like Mary were competent, if slow. "I'll take it from here. Looks like about as far to the corpse as to the beach. No problem; I'll just swim in when I'm done, or I'll buzz for you if I need back-up. OK?"

He rumbled an assent, she bared her teeth to him, flipped and started pulling herself through the water toward the victim, climbing through the waves with steady pulls of her front limbs. The wonder, he reflected, was not that his simian friends were slow in the water, but that they could swim at all, and even appear graceful, in their

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own way, while doing so.

"I'll be expecting you. Take care," he called after her. Then, with mixed feelings, he sent himself toward the beach.

The approach was not the simple landing of a human boat ramp. Jagged rocks were all over. The beachmaster had chosen well: an adult Do'utian needed care to reach the shore. Drin exhaled and settled firmly on the bottom to ignore the random swells. Legs extended, he picked his way carefully along, a Charter unit below the surface, while holding his sonar transceiver high over his head, hearing the image it received through his earphones. There! A sandy path opened through the rocks. He followed it. It zigzagged to an open gravelly area under the breakers that seemed safe enough, but he chose to pick his way through the smooth stones along its side just in case. Carefully, he emerged onto the beach.

The women cowered together as soon as they saw him. Very well, he'd take it slowly.

First though, he traced his route with a sharp tongue tip on his comset's screen and sent the resulting image to Mary. While she could float over larger outlaying rocks that would disembowel him, there seemed to be only one place where the breakers might not dash her to pieces. He also sent a brief report to Monitor Central and inquired about the status of his request for Kleth support. Scheduled, they told him.

Chores done, he returned his attention to the widowed harem. Widowed because they had been very clearly scented by the dead beachmaster, and the deceased's neobarbarism seemed to have extended to marking them physically as well as with his scent—some of the scars were still unhealed.

A medical team would be needed. While, contrary to his initial assessment, only two of them were gravid, with the beachmaster gone they would both be needing egg relief soon. Also, all four were clearly undernourished.

He filed a quick report for Do Tor on his comm unit, then walked forward to them slowly, mouth politely open, tongue and manipulators spread to signal peaceful intent. Still, they cowered. They were young, very young, despite scars and abrasions on their hides that most of his people wouldn't acquire in eight times eight times eight years, and would probably remove if they did.

"I'm Lieutenant Drinnil'ib from the Monitors. I don't mean any harm," he said. "I'd just like you to answer some questions."

It must be the smell of the beachmaster's death that frightened them into silence. He had come close enough to carry some of it, and they probably thought he was responsible.

They keened and backed away as he approached. But a cliff surrounded the beach, and soon they could back up no farther.

If they could smell the death, then there was no reason to try to

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keep it a secret. He was hoping to avoid the legendary consequences. Nonsense, he told himself. These must be at least semi-educated people, living in primitive conditions by choice.

"I'm sorry to have to bring you this news. I've come from the North Pole colony investigating the reported deaths of several people in this back-to-nature area. I'm afraid I have one more to investigate. By what I smell, the latest victim was your husband. I'm sorry. I assure you I had nothing to do with his death before the fact." Lieutenant Drinnil'ib reached into his pouch and produced his badge, a holoprint two docis on edge—big enough for them to see easily. It gave off his scent as well.

The smallest of the harem, with deep black scars on her forelimbs, finally walked forward, then lowered herself to her belly in supplication.

"No," he protested. "I don't want you to do that. Stand up! Speak to me, please."

She keened again, then opened her mouth wide. It took him a few heartbeats to register what he saw, and then a few more for the horror of it to sink in. Where the two branches of her tongue should have been, where the manipulators that signified their species' rise from the beach should have curled, was nothing but a blackened stump, so short it would be useless for feeding or speaking.

He quickly pulled in his own tongue and lowered his belly to the gravel, to be on her level. Then he gently touched his beak to hers in sympathy. She shut her eyes and lowered her beak in sadness, and he did the same. When he looked up again, the other three had joined them. The gravid ones were looking at him expectantly. Oh-oh.

"Look," he explained, "I'm not part of your culture. I'm a Monitor. This is strictly a professional visit." Their eyes showed no comprehension, and their bodies began to sway back and forth on their legs. They came closer, swaying and keening. The first female kept nuzzling him. He tried to back away, but froze.

From then on, he noted his body's response with what was almost detachment. Body temperature up. A tightness at the base of his tail. He wanted to keep his mouth shut to avoid tasting whatever chemicals they were putting out, but a groan worked its way out from deep inside him, his beak yawned open involuntarily as reason left his brain. The women were beside him, keening, holding him between their bodies, their beaks locked wide open, pressing his most private areas. The need to give overwhelmed him. He let his tongue caress their tails, almost as if it were someone else's.

He never saw the eggs emerge from their throats, but rather felt the smooth bumps against his underside, an emptying feeling in the base of his tail, and a slight coolness in that area as his consciousness slowly faded back in.

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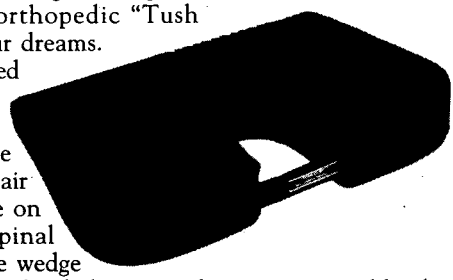

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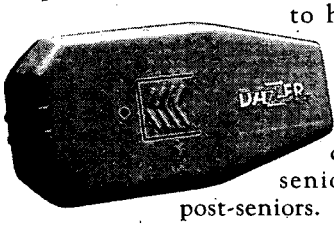

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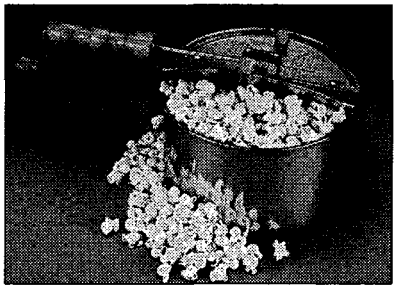

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Afterward, of course, he remembered everything with the humiliating clarity of a terapixel hologram. Especially when he looked back at two white eggs covered with sticky yellow goo. And especially when he looked up and saw little Mary Pierce standing about eight Charter units away, mouth open in what must have been a look of horror.

Setting aside his embarrassment and disgust, he tried to remember what needed to be done. Back home, in a hospital, the eggs would be sprayed clean and anointed with all sorts of healthy fluids, wrapped in germicidal barriers, and placed in an incubator. The nearest thing to an incubator they had here was a Do'utian pouch. His was full of other things, but the women had pouches, too.

It was then that he realized that since none of the women had tongues, he would have to place the eggs in their pouches himself. He shut his eyes, moaned, and buried his beak in the sand again. He couldn't do this.

"It's OK," he heard Mary say. "I'm afraid I don't remember what the handbook says about Do'utian midwifery, but if there's anything I can do, just tell me."

He lifted his head up. "The handbook doesn't say anything. It's supposed to be too private. But . . . but the eggs need to be cleaned off and placed in the women's pouches. They can't do it themselves because their former husband disabled them. I'm . . . I'm afraid I'm not up to it."

"No problem, buddy. I think they accept me. Must be your scent all over me. Is it OK if I wash the eggs in the sea?"

"Yes, I think so."

She did this quickly and efficiently, taking each egg in turn, cradling and talking to it as if it was a fresh born human. Drin refrained from telling her that there would be nothing inside the eggs to hear her for eight-squared days. Done with the washing, Mary took the smaller egg and approached one of the formerly gravid women, who looked accusingly at Drin and backed away. Then a strange thing happened. The smaller Do'utian woman quickly moved in front of Mary and offered her own pouch.

When that member of the harem had accepted both eggs, she came over to Drin and slowly scratched the sand with her beak. It soon became clear that she was writing. When she backed away, Drin could read, fairly clearly. "I GRI'IL."

"You can understand me?" Drin asked, wonderingly. Obviously, she could not speak.

She nodded.

"Your name is Gri'il?"

She nodded again.

"Do you want to leave?"

Gri'il did nothing, then nodded slowly, followed by a vigorous head shake. Something wrong.

"Will you follow me back to the North Pole? To civilization?"

She was still a very long time. Then she began painfully scratching the gravel again. What she wrote was "DANGR HUNTRS."

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Mary saw this, went up to Gri'il, wrapped herself around the Do'utian woman's foreleg, and began her own type of keening. Soon, they had all joined in.

"I'm going to get some fish for everyone," Drin said to no one in particular, and trotted back to the shore. The mutilated Do'utian's were ill nourished and couldn't feed themselves. Besides, he needed something to do alone. Away from all women of whatever species.

Individuals who wish to visit or reside in the wild regions, alone or in small groups, may do so without interference so long as they respect the rights of others and do not significantly disturb the environment. Introduction of chemical industry is specifically prohibited. Alternative societies are permitted so long as the individuals who join such societies are free to leave such when they wish. Do not interfere with suicide, or risk-taking that amounts to such. However, murder will be treated no differently than in the civilized areas.

—Planet Monitor's Handbook,
Law In Reserved Areas

"Gri, Ohghli, Donota, Notri, do I have it right?" Mary asked. Human memories, Drin thought, were amazingly poor considering their technological prowess—on the other hand, perhaps necessity had made them superlative inventors.

Drin rocked her submarine by putting a little extra into his next propulsive tail-stroke. "Your memory is either much worse than I think or you find a certain humor in my situation. I think I would rather not have my thoughts in that current so often."

"My apologies." The comset relayed the drop of pitch in her voice that Drin associated with increasing concern. "But they're your wives now, aren't they?"

"No! I have made no commitment. There is no registration. Except for Gri'il, none of them seems to have any intellectual understanding of their lives, or that of the broader race. None of them is a suitable mate."

"I'd guess it will be hard for them to understand that," Mary suggested, more right than she could know.

"Very hard. I approached them under circumstances that make biological bonding almost inevitable in nature. And Gri'il took the eggs. . . ."

"She seems the responsible type, and educated somehow."

"She will have a tale to tell. I suspect she is a truant who dove into the back-to-nature business just a little deeper than her inherent depth. The others, I think, must have been born here. They seem virtually feral."

"What will happen to them?"

"I think Gri'il will return to civilization, sadder but wiser. The feral women . . . I don't know. The experts will have to decide—they may be happier as they are."

"Mutilated?"

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"No, we'll fix that. But, they may be unable to adapt to civilization now. I cannot know their minds, or even if they have developed what you and I would recognize as a mind."

"That's heartless," Mary accused. "They love you."

"You don't understand the biology. I think our conversation should find different currents now."

But it didn't. Mary's attempt at matchmaking left him in no mood for conversation at all. There was silence instead, a silence that should have been filled with plans as they approached the primitivist human settlement.

It was shockingly big, even by his standards. Primitivism in humans, Drin realized at the sight, didn't really mean living without technology. It meant living with a technology so primitive that it could be sustained without any meaningful education at the expense of ceaseless, boring labor; a technology of hand-hewn planks, poles, and rough-cut stones in huge piles, piles made all the larger by beings who evolved with twice the local gravity.

The entrance to their harbor had been choked down to a canal by massive stone walls and guarded by massive wooden grates. The stream that issued from this was putrid. Drin turned away.

"Pollution! Mary, I think I would prefer to walk in."

"Understood. There must be two thousand people in this place, and that's the only outlet. The air isn't a whole lot better—lots of smoke. It's a couple of degrees over freezing; cool enough for you?"

"A nice balmy day."

"Why don't you try riding on top of the sub? You'll have to keep your tail off the rear electrodes."

Drin released a bubble of humor; the idea of him riding on a human submarine was indeed bizarre. But the water stunk like rotting carrion. "If you can steer without your forward fins, I could hang onto those with my forelegs. Then my tail wouldn't reach the electrodes."

"The sub says that's no problem. Climb aboard."

He swam into position, curled his front toes around the rounded edge of the flexidiamond fins and released some buoyancy gas to hold himself down. The submarine rose under him and broke the surface. The air stank as advertised, but only when he opened his mouth.

Soon Mary climbed out of the nose hatch to join him. She'd put her monitor uniform jumpsuit on over her insulated tights and looked academy sharp. Remembering that humans relied almost exclusively on visual identification, he pulled his monitor badges out of his pouch and stuck them on his front shoulders.

In front of them across the harbor entrance lay the top of the harbor wall, with an opening just a little wider than the submarine, the massive wooden gate was solid above water and dwarfed even Drin. It was guarded by heavyset humans in thick-belted robes

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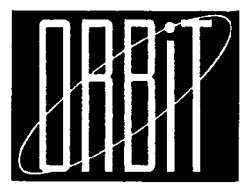

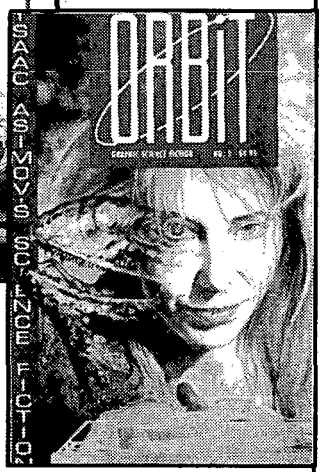

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around which were buckled long, heavy, cutting tools; called swords, if he remembered correctly.

"Open the gate," Mary yelled. The men did nothing. Drin tapped her on the shoulder with his tongue to warn her, and she covered her ears. He took a large breath.

"PLANET MONITORS. OPEN THE GATE!" Drin yelled, two octaves lower than Mary, pouring air from his bladder as well as his lungs. The human guardhouse resonated nicely with his undertones and a satisfying crash emerged from its open door. Various stones and pieces of rotten mortar came clattering down the sides of the wall. One of the men extended his hands, palms out as if to plead for patience, while the other dipped into the now-steady guardhouse and emerged with a pair of colored flags. He faced the harbor and started waving them in various incomprehensible patterns.

Soon, they heard a screeching and groaning of hidden wheels and levers as the left gate swung ponderously open. From aerial holos, Drin knew the breakwater was eight squared Charter units thick, but even so, the narrow canyon revealed by the opening gate made him shudder a bit. He slipped a branch of his tongue out the corner of his mouth into his pouch, and wrapped its fingers around his weapon. When the noises stopped, the submarine nosed through the half-opened gate. It had only a few doci's of clearance on either side, but it maintained this clearance with mathematical precision as it moved smartly into the channel.

About halfway through, a red-robed human man jumped onto the hull from a ladder just inside the gate, landing without stumbling despite the vessel's speed. He looked at Drin, then at Mary, apparently unsure of whom was in charge; the male Do'utian or the female human.

"Who are you?" Drin rumbled. the man shook and looked around, as if for somewhere to jump, and finding nowhere, finally faced Drin.

"Yohin Bretz a Landend. I'm . . . I'm your harbor pilot. We've got to go to city gate. Lord Thet will talk to you there."

"Yohin Bretz a Landend," Mary said, "I'm Mary Pierce from the monitor bureau. This is Lieutenant Drinnil'ib, my colleague. This is my boat; Lieutenant Drin doesn't need one. We are here to investigate the deaths of several Do'utian primitivists in this region."

"Huh? Whalers playing games with the fish-people, I'd guess." Bretz looked down at the submarine. "What do you draw?"

"Draw?" Mary clearly didn't recognize the term. Drin did, from his readings in human nautical literature, but kept silent so as not to embarrass his partner.

"Yeah, *draw*. How far down is the bottom of this thing?"

"About a third of a Charter unit," she answered.

"What's that in meters?" A human chauvinist, Drin thought.

"It's a little over three of the old meters."

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"Uh huh. So the keel's about twice your height below the waterline?"

"Yes."

The pilot shook his head. "You'd displace thirty ton less without the fish-man on board, I'd guess, and ride a meter higher. Well, no problem, the channel's deep enough, but you'll have to stay in it. You've got to go hard aport as soon as you're out of the dike canal and steer for the big stone mill you'll see on the shore. Bear a bit to the port of it to lead the current, if I were you."

Drin rumbled a bit, and Mary smiled, recognizing his laugh. The submarine could follow the channel on sonar or with blue light without any help from the pilot.

"We'll do just fine," Mary said, "thank you. Now you can call me Mary, what can I call you?"

"Yohin, or Mr. Bretz to be polite."

They emerged into the harbor, a roughly circular body of fetid water. The air was thick with the smell of fish and dark with wood smoke. Now and then a flake of white ash would fall on them. Rough wooden human buildings lined the shore except for the far end. There, across the middling stream that struggled to flush the place, was a large stone wall, more vertical and smoothly finished than the dike across the harbor entrance.

Against this dock were tied wooden ships including several small round vessels not much longer than Drin himself, set with triangular sails, and a massive square-sailed ship—perhaps ten Charter units long. The last also had a strange, forward-projecting bow and two rows of oars with which it could presumably maneuver without wind.

"Hey, we're in the harbor!" Yohin shouted. "Don't you have to do something to turn this boat? How the . . . ?" His eyes went wide as the submarine turned to the channel without Mary doing anything. Drin rumbled again.

"Tell me, Mr. Bretz," Mary laughed, "Are you happy here?"

"It puts bread on the table. Feeds me and my wife, gets me some respect. Even got a couple of slaves. I've been doing it 150 years. Yeah, I'm happy. Don't need any fancy stuff."

"Slaves?" Mary asked. "You have slaves?"

"Sure," Yohin said. "Someone's got to do the work while I'm out piloting. Be a shame if my wife had to, and I'm too tired after a day of this."

"Are the slaves happy?"

"I feed 'em well. They don't know anything else, so why shouldn't they be?"

Drin hissed. This manifestation of disgust, he realized, was wasted on this human pilot. "Do your slaves want to be slaves?" he asked. Yohin turned to him in surprise.

"They were captured fair and square. They know the game. What business is it of yours, Mister, excuse me, *Lieutenant* fish-man?"

"The primitive lifestyle is sup-

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posed to be voluntary. No one should be compelled to live like this."

"Look, I didn't set this up. But if you come after my slaves, you got an argument with me. Maybe from them, too. What would you do with them? Send them to some machine school so they can contemplate their navels for the rest of eternity? They're better off working for me."

"Now, lady," the pilot waved his hand at the other side of the harbor, "you've got to turn this tub sharp starboard and make dead on for the flagpole on the end of the fort . . . however you do it."

The submarine turned as if to the pilot's command, and he nodded judiciously.

"Never knew a woman could run a boat. But you do OK."

"I've got a lot of help," Mary said. "Yohin, I can imagine you doing this in one of those sailing ships with the wind blowing, using only your judgment and what you can see from the surface. I respect the skill you need to do that."

The pilot nodded his head and bared his teeth again. Mary, Drin realized, was gaining trust.

This human, Drin thought, had found whatever Gri'il had been seeking when she left civilization for the beach. The question was whether the failures should be allowed with the successes, particularly if the failures were involuntary.

"You said something about the whalers playing games with the Do'utians. What kind of games?"

"I heard there's a deal where the fishmen try to outfox the whalers. Them that lose are meat, but word is that's how they want it."

Drin rumbled his skepticism.

"Who sets up these games?" Mary asked.

"How the hell should I know? Maybe Lord Thet does. You can ask him, we're almost there."

The submarine's hull was well below the level of the dock, due in part to Drin's massive presence. From sea level, he couldn't see the rest of the top of the dock. The angle got worse as they fetched up next to the stones.

Carefully, using the wall as an additional point of balance, he swung his tail over the side and reared up on his hind legs, hooked the rippled pads of his front toes over the edge of the stone wall, bringing his head above dock level.

The man waiting for them on the dock by the city gate was probably Lord Thet. He was a head taller than Mary, gray-robed, and had thick black hair all over his face so that only the eyes and the nostril wattle showed when his mouth was shut. His robe covered either armor or what would, for a human, be an exceptionally large body. Others of his kind, holding metal-tipped spears, stood beside him. Perhaps fifty humans carrying some sort of primitive wood and cord weapons stood well back of the primitivist leader.

Mary was able to scramble up his back and jump from his shoulder to the stone platform. Undignified, but

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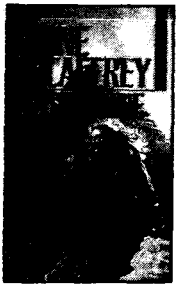

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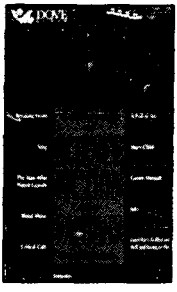

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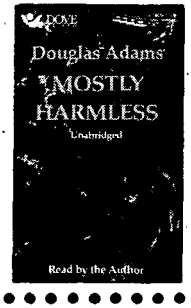

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it got the job done. There was a fair amount of wind and harbor noise, but Mary left her comset on her belt, where it could see and record everything. Drin listened through his earphone.

"Hello, I'm Mary Pierce, Planetary Monitor."

"You are not wanted here," Lord Thet stated—with aggressive impoliteness, Drin thought.

"Your name?" Mary asked.

The man remained silent, but the comset camera got a good look at him and the Monitor net quietly relayed the information through their earphones. He'd left civilization early in life and, despite his commanding presence, was largely ignorant of things beyond what he controlled.

"You are Jacob Lebbretzsky, otherwise known as 'Lord Thet' according to your voice and features. I'll be gone fairly quickly if you answer my questions," she told him.

"Don't overestimate your authority, Monitor. Your superiors are not that interested in us and your charter is open to interpretation."

Wishful thinking on his part, Drin felt—while the Monitors would bend over backward not to be overbearing, there was no question about the final outcome.

But only he and Mary were here right now; things were nowhere near final, and if this egomaniac idiot had talked himself into believing he could get away with minor violence . . . or if someone else had talked him into believing. . . .

Drin spoke quickly with his beak shut so that only Mary could hear him on her earphone. "Mary, this fool could be dangerous. He's gotten so big he's forgotten what's backing us up."

She raised a hand to acknowledge him, but continued to face Lord Thet. "Someone's killed at least four Do'utian primitivists," she told him.

"Have the fish-men accused us?"

"We found the bodies."

"Death happens. Only the untested live forever."

An ancient Do'utian philosophy, Drin thought. Why was he hearing it from an ignorant human primitivist? Do'utians did not die of old age, but reproduced slowly enough that in the natural state, mating battles, disease, and accidents of the hostile sea were enough to maintain a population balance. But humans had eliminated aging and limited fertility with genetic engineering in historic times.

"You hunt them, don't you?" Mary pressed. "Your people hunt them in ships, as if they were animals."

Lebbretzsky was silent for a heartbeat or so, then said, "The contest is more even than that. There is no opportunity for heroism on either side without the opportunity for death. And the deaths let us raise new children uncontaminated by your machine culture."

This made Drin hiss as he thought of the stinking harbor, the human slaves, and the feral Do'utian women in his "harem."

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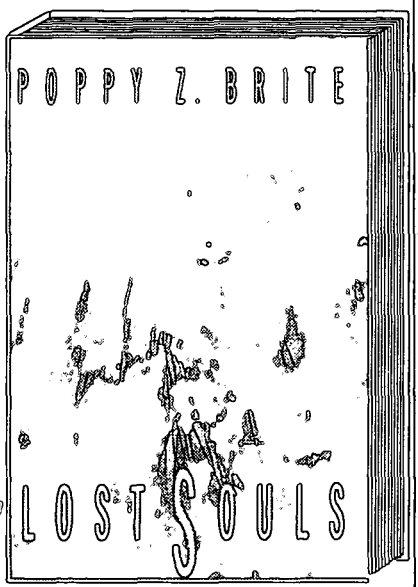

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The sound got the momentary attention of the human, who probably had no idea of what it signified.

"Mr. Lebbretzsky," Mary responded, "I take your statement to mean that you know what I'm talking about. It has to stop, and the persons responsible must be reeducated. If you attempt to conceal them, then you will be a candidate for reeducation yourself."

Drin saw the man raise his arm as if to strike Mary, then put it down. Lebbretzsky, Drin realized, might be so ignorant and so deeply into these murders that he felt he had nothing to lose in an attack on a Monitor. Drin slipped a manipulator into his pouch holster for the second time. The movement of his tongue seemed to go unnoticed, or at least uncomprehended.

"Woman. Tell your superiors that your presence is an insult. Tell them that their interference with our culture is an interference of our rights to live and die the way we want. Tell them that we have not murdered anyone, and that the next time they want questions answered, not to send women and fish to ask them."

"Pollution!" Drin sent. "The victims were stabbed and butchered! But be careful, Mary."

The man continued: "There are no murders, woman Monitor. Now get out of here, or we will do what we can to eject you. You may have better weapons, but we are not afraid to die."

"Drin, better call that Kleth backup," Mary said aloud. Drin almost rejoined that he had done that hours ago—then realized that Mary was saying that for Lebbretzsky's benefit,

"Lebbretzsky," she continued, "I don't care what you think it is; attacking and killing Do'utians with harpoons is murder just as much as if you did it to me. The cultural group can deal with the whys later, but my job is to stop it, now. Who has been doing it? Where are they?"

Drin tensed. Mary, in her fearless eagerness to erase what she saw as a blot on her race, was pushing a bull on its own beach. Wrong species, but in this case, Drin feared some convergent evolution. As if to confirm his thoughts, the big human drew a long knife. Mary backed quickly away from him and got her gun out. Drin put a manipulator in his pouch and keyed his comset by feel. He dumped everything they had so far into the Monitor net—just in case he and Mary didn't survive her abuse of Lord Thet's hospitality.

"All right," Mary yelled. "Lebbretzsky, drop the weapon and lie down. You are in custody. You can arrange representation after you've been secured."

"Mary . . ." Drin sent. Too late. Lebbretzsky's hand seemed to flick and the knife flew at Mary. Her gun got it on doppler, flashed, and a smart bullet locked on the thing and knocked it out of the air. The two humans stared at each other in silence for a few seconds as if in a momentary stalemate. But here and now Lebbretzsky had overwhelm-

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ing numbers. He made some kind of a signal and a hundred darts flew at Mary, some at Drin. He and Mary both fired as fast as their weapons could, but Mary was hit.

"Got my leg," she said with professional calmness. "Drin, let's get out of here."

Drin roared and with the occasional supreme effort his race could summon, pulled himself over the edge of the dock and scrambled toward Mary. The human archers paused in surprise and he flung his tongue out to his injured partner. He was just able to grab her leg with one manipulator and was pulling her to him when the primitivists started shooting again. He reeled Mary in with one manipulator while the other sent smart bullets at the legs of the crossbow archers.

Mary, a small moving target, wasn't hit again. But despite both their guns knocking dozens of darts off their trajectories, he was hit himself. The darts irritated like the spines of the giant dagger snail, but none seemed to reach below his layer of fat, and none had hit his eyes. Some of the men with swords charged at him. He waited until they were too close, then quickly turned and swept the polluting snailbrains over the side of the dock with his tail. Then, with Mary firmly in his beak, he leapt into the harbor after them.

"Hold your breath," he said on the way down. He landed so as to spray as much water around as possible.

Momentarily sheltered by confusion and the high wall, he had time to help Mary into the submarine hatch. Then, thinking of the large harpoon he'd seen in the erstwhile beachmaster, Drin headed, fast and direct, for the harbor entrance. He sprinted through the harbor with a surface-racing tail-stroke, and used his legs to help him over the shallow spots. This time, he didn't even notice the dirty water.

A look back told him the human primitivists were busy with their colored flags again, and when he ducked under water he could hear the sound of the harbor gate creaking shut. Another look above water showed him that the large ship with oars was underway and pursuing them.

He reached the canal through the harbor wall well before the submarine, and sped to its end. But the massive gate was already closed and locked. He put his beak against it and pressed as hard as he could, and the thrusts of his tail sent waves of brackish brown water back down the channel. The gates hardly noticed.

He surfaced and scouted the channel walls. They were not quite vertical, perhaps widening half a Charter unit over two Charter units of rise, and the cobbled surface provided plenty of claw holds. It would not be out of the question to attempt to climb it.

But first he tried bellowing at the watchmen to open the gate. Not to his surprise, they refused. He did, however, have the satisfaction of

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seeing their little guardhouse collapse from resonance. Looking back, he saw the submarine enter the channel with the oar ship in hot pursuit.

"Mary, what's your status?" he sent.

"I got the dart out, patched the wound and patched the suit. Hurts like hell. I won't be running around for a while. I'm a little worried about that ram."

"Ram?"

"That rowboat with the solid nose that's chasing me. It's got to weigh a cube, it's moving fast, it's built to bash things, and it doesn't have any brakes. How are you doing on that gate?"

Weigh a cube? That was about eight-times-four as much as his body. Pollution!

"No luck at all," he sent. "Any chance your submarine can ram it open?"

"I'll try the underwater grate. That has to be the weak point."

Drin moved to the side of the canal and watched the humped deck of the submarine flow by him. Its wake grew, then disappeared. There was silence for a heartbeat, than a muffled boom. The gate held.

"Mary?" he asked.

"I'm OK, considering. Might have done some damage. Going to back off for another try."

She did, but that was no more successful than the first.

"Drin, if you can climb out of this, you'd better get going."

The primitivist ram had entered the canal at full speed. Clearly, they were going to try to crush both Drin and the submarine between the ram and the gate, regardless of what damage that did to the latter two. The slaves rowing the ram, he realized, probably didn't know their ship was charging at a locked gate. And its officers must believe, wrongly, that destroying Drin and Mary gave them a chance to avoid reeducation.

But there was no chance to discuss it with them now. Drin threw himself at the canal wall and his legs found claw holds on the rocks under water. Carefully, he heaved himself up the near vertical embankment. But as soon as he tried to put any weight at all on his forelegs, claws slipped on the damp mossy covering of the stones near the waterline, and he tumbled back into the canal. He tried it once more, then saw the submarine break the surface and start accelerating backward at the ram.

"Mary!" he bellowed, forgetting the comset.

"I got us into this, I baited them. I'd rather go down fighting." Despite the brave words, her voice trembled. "Good luck, friend."

He clung half in and out of the water like a paralyzed lungfish and watched the two human vessels collide. There was a tremendous thundering boom as they hit, followed by cracking and splintering sounds. In seeming slow motion, the ram rode up over the submarine and the rock walls transmitted an eerie hollow grating sound to him as the submarine's keel scraped

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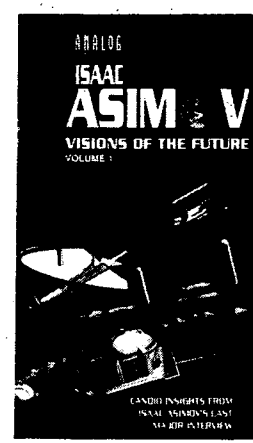

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along the canal's stone bottom. The combined wreck grated down the channel with scarcely diminished speed like a piston toward the massive gate.

There was too little room for him to remain where he was. He released his hold, slipped back into the water, and swam for the gate. Maybe everything would grind to a halt before it got there.

Underwater, Drin heard a sudden, ear-piercing crack. Pollution! he thought, the hull of the submarine must have broken. He surfaced and looked back. Both ends of the submarine stuck out of the water. The primitivist ship rode farther up on one of the pieces and then fell off to the side, gouging its ram into the side of the canal. Its stern hit the other side and, with a great screeching and rending, the keel of the ram snapped, leaving the broken human ship stopped sideways in the channel. Men, some of them skewered by splintered oars, tumbled from the broken vessel like fish from a torn net. The mess ground to a halt just a Charter unit from the gate.

"Mary?" he sent. There was no answer. Flames, from spilled heating fires aboard the ram, or discharging power leads on the submarine, began spreading in the above-water wreckage.

Drin threw himself into the devastation, prying blood-stained pieces of the ram away from the broken submarine hull. There was movement all around him, and he saw that the human survivors were having no better luck than he in climbing the slippery canal sides. Hoping that the time it took would not prove critical, Drin seized the still upright mast in his beak, snapped it with a vicious twist of his body, and let it fall so that its top rested on the dike above.

"CLIMB!" he roared to anyone who would listen.

Some of the astonished humans caught on and began scrambling up the mast to safety above. One was a large red-bearded man—the same one, he realized, that had mocked him from the decks of another ship only weeks ago. They stared at each other in a frozen moment of recognition, but Drin had more than an arrest on his mind.

Ignoring minor burns and lacerations, Drin clawed away the remains of a lower deck to expose the broken pressure hull of the submarine. It was filled with water. Drin stuck his tongue in and located the cockpit from feel and memory. Mary was not in the seat, but he could scent her blood. He felt around the tiny compartment, using both branches. He found her underwater gear, and, presuming success, grabbed it. A few more precious seconds, and he found Mary motionless in a small air pocket near the back of the cockpit.

With both branches wrapped around her, he strained to pull her up like a hatchling, into his mouth. With her legs sticking painfully down his throat, he was just able to close his beak over her head. Then he smashed his way out of the

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wreck, inhaled an hour's worth of air, and dove back into the putrid water. Over-buoyant, he swam down to the wooden grid and held on with his legs.

There was hardly room for both Mary and his tongue, so, with the skill of a contortionist, he managed to slip a loop of the tongue out the fleshy corner of his mouth, leaving the ends of the manipulator branches inside. Drin lowered his head and squeezed water from her lungs. They reinflated on their own as he forced the water from his mouth with air from his bladder. He squeezed again. She moved. Conscious? He hoped she would understand quickly enough not to panic.

He felt her hand pat one of his fingers. It seemed a controlled, understanding, gesture. He turned his attention to his external predicament.

With gloom and debris in the water, and Aurum low in the antarctic sky, he should be invisible from above. He began exploring the bottom of the gate where the submarine had smashed into it. Here and there, an outer buffer of great tree trunks had been smashed to kindling. But nothing behind had broken enough to let him through.

There was purposeful movement inside his mouth. "Drin, I've got my gills on. You can let me out now." Mary's voice in his ear was the best news he'd had since he'd come into the primitivist cesspool. Using his tongue to keep her from bobbing to the surface, he expelled the bubble of air from his mouth, then let her float free.

"How do you feel?" he asked.

"Lousy. No broken bones, I think. Tired. I've still got a little fluid in my lungs." She drifted slowly over to the grate and surveyed the damaged grate. "I guess I didn't put a hole in this thing."

"It appears not."

Trapped. They were both silent.

"Uh, Drin? Can you think of any way we could make them think I did break through? If they think we're already gone maybe they'll open the gate to come after us, or to clear the floating debris."

The grate was too fine for even Mary to squeeze through—it was probably designed with human sappers in mind. His tongue could just fit, but wasn't long enough. But maybe . . .

"I could try to blow a bubble with some debris through the grate and out the other side."

"Hey, go for it!"

He did it, placing his blowhole against one of the spaces between the beams of an undamaged section and blew. Some of it escaped on their side, but not much—some must have gone through. They waited for a subjective eternity. He was on the point of suggesting another frontal assault when they heard a hideous, hollow, creak.

They waited. Nothing.

Then another creak. Drin thought he could detect a slight shudder.

"I think they're trying to open it," he said. "You might have jammed it a bit when you rammed it. That's a

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case of an emotional, spur of the moment action that did exactly the opposite of—"

"Drin, your folk's eyes are built for hindsight. Why don't you stop philosophizing and just try to help them open the gate?"

Of course. With a firm clawhold on the bottom stones, and not having to fight gravity, Drin could apply his full strength. He waited until a creak signified another attempt to open the gate, then *pushed.* Slowly it began to move. There was a crack and a grind as something let go. Drin released his hold immediately, and the gate began to swing open on its own.

Hiding on the bottom beneath flotsam from the wreck, they drifted with the current out through the opening. Then, with Mary hanging onto a leg, he swam hard for clear water until he judged they were well over Lord Thet's horizon. He surfaced, turned on his back and sheltered Mary between his legs as he would a hatchling, and let horizon-grazing Ember and Aurum do what they could to warm her, while he took great breaths through his mouth to rid himself of heat and to pay his oxygen debt.

Mary was quiet for a while, exhausted Drin surmised. So it startled him when she suddenly sat up and yelled: "Look, Drin, contrails!"

Do Tor had finally arrived.

Among all races, when violence is obviously futile, reason is encouraged. For this reason, where there is the likelihood of an irrational physical confrontation, the inclusion of a large Do'utian Monitor is highly recommended. Humans excel where strength is needed in confined places. And, where overhead intelligence and logistic agility are required, the Kleth can make a major contribution—but care should be taken to avoid endangering Kleth individually.

—Planet Monitor's Handbook, Team Composition

. . . their mating bond is such that individuals become physiologically dependent on each other. A Kleth seldom survives the death of a mate, nor is their any record of one wanting to do so. Efforts to sustain life in these circumstances are always futile and should not be attempted.

—Planet Monitor's Handbook, Medical Appendix

The Kleth aircraft met them just over the horizon from Lord Thet's city, on the beach of an uninhabited island dominated by a huge granite crag that gave shelter from the circumpolar wind. After greetings, Team Leader Do Tor and his mate started unloading supplies.

Mary was exhausted, so Drin scraped a deep pit in the sand for her, gathered wood, and lit a fire. Then, despite her exhaustion, and still limping from her wound, she insisted on washing her clothes and body in the frigid polar water, and turned an amazing shade of blue before she got back to the fire.

"D-don't worry," she told him as

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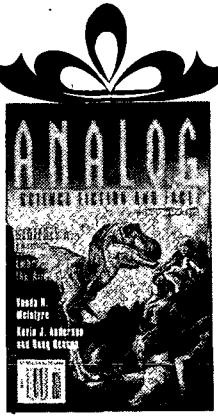

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she shook convulsively under a blanket in front of the fire, "It's-s h-how we get our b-body heat b-back up."

Do Tor and his mate stretched their wings to catch some fish for her, and jibbered with amusement as she threw away all the good parts and heated the remaining muscle almost to the point of decomposition on a flat stone she put by the fire. Drin looked forward to having a good long feed later that night, in his own manner, on his way back to Gri'il's beach.

"Sorry late. Assumed you'd just leave Thet and wait for us," the Klethan said in a guttural, sing-song English that was actually lower pitched than Mary's, despite his being less than half her mass.

"We tried," Mary laughed. "Things got in the way. We surface dwellers have certain problems about just flying away when things turn sour."

"Don't understand why primitivists had so much technology."

"Lack of interest on our part. Ignorance of the Charter and evolutionary pressure on theirs," Drin offered. "The best fighters end up in charge, and the best fighters are, more often than not, those with the best weapons. Also, if you can't make it clever, make it big." It would be a long while before he would forget the huge ram bearing down on him. "I doubt that Lord Thet or many of his people even understand why the Charter prohibits development in these areas; they've rebelled against anything resembling a scientific education."

"For humans, there is an inherent contradiction between 'back to nature' and 'no technology.'" Mary contributed, "because human nature *is* to make and use tools. So what happens is that the primitivists reinvent the wheel using primitive technology that, per capita, pollutes unmercifully and requires gobs of labor." Mary picked up a stone and threw it out of sight. "So then you get leadership dominance games that the most ruthless win, with slave labor of one sort or another for the losers. That works well long enough for the glandular bullies to start assembling miniature empires, and then..." She shook her head. "Allowing this Lord Thet set-up was taking noninterference too far, in my view. But that's up to the council. Anyway, we have our killers."

"Maybe," Drin demurred. "But I don't think this is a one-species issue." From a philosophical standpoint he certainly didn't want it to be human versus Do'utian, but something more than that was bothering him. "I'm not sure we have the whole story. In defending his hunting, the human Jacob Lebbretzsky seemed to include the Do'utian primitivists in his defense."

"Do'utians help get selves butchered?" Do Tor clucked. "Strange thing, I think."

"If you think in groups, yes. But that isn't the natural Do'utain way to think." Drin moved his head slightly from side to side in mild

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negation. "I want to ask Gri'il some questions and learn more about this murdered beachmaster and his harem. I may have made some unfair assumptions about the last victim."

"Name was Glodego'alah, by the way," Do Tor added. "Left the north pole as a disillusioned student eight cubed great revolutions ago. Not happy as primitivist, either, but responsible. Took care of harem. Good being. We did our homework." The Kleth held its hard translucent wings out in a gesture of pride.

"Oh yes," his mate said, the first words she uttered, surprising Drin. Until now, Go Ton had been inert, folded up. One partner or the other might dominate, but they were always together. Divorce was unknown, as were widows or widowers. Go Ton's contribution was unusually forward, for a subordinate Klethan. But Monitor couples were known to be more independent.

"Did you bring the Do'utian interface coronet?" Drin asked.

"Not so late, otherwise." Do Tor rummaged in the pile of unloaded supplies and found a glasscloth package the size of a folded human tent. "Here."

Drin placed it in his pouch. Its woven-in antennae picked up and decoded motor nerve impulses —even those sent to absent peripheries. Now, not only could he ask questions of Gri'il; she would be able to answer.

There were also a tent and collapsible kayak for Mary. The tent fit nicely in the hollow he had dug, and she opened it up with its door to the fire. As it resumed its memorized shape, she turned to her fellow monitors.

"This," she said, "is camping. It's what most of us have in mind when we think of going back to nature, or living in a primitive situation. But, as you see, it's not primitive at all. And it's not social, we usually try to get away from other people when we do this. What's happened back at Thet just hasn't really registered with my people. I—"

"Mary, why should it register with you any more than with the rest of us?" Drin interrupted. "You have no special responsibility for them just because they happen to be human. There is no need to apologize."

"Oh yes, Go Ton agrees," Do Tor's mate spoke up. "We are one civilization on this world. Whole purpose of Planet Trimus. Eight-cubed years of lives meaningless if not. Eyes of Trimus we are. We should have noticed violations before dead bodies appear."

"Any Do'utian can smell that place in currents an eighth of the way around the planet. We ignored it," Drin said.

"Th-Thanks," Mary said. "I just . . ." She shook her head and made sounds of human sadness, though Drin thought it was more in relief. He flicked out his tongue and wrapped his fingers around her hand, and she rewarded the gesture by squeezing him gently back, and

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baring her teeth in a big smile.

"We all go to the beach tomorrow, and gain more understanding," Do Tor said. "Now rest."

"You rest," Drin answered reminding him that Do'utians didn't sleep in the eternal days of a polar summer. "I need to eat, feed the harem, and keep my injuries in water until they heal more. I will see you there at the beach. Take care, Mary."

She hugged his fingers to her, careless of her wrap, and his most sensitive organs were pressed into the alien heat and smell of her. He was overwhelmed for a moment, then she released him. "Yeah, you too," she said.

He backed away from the fire carefully, to avoid upsetting anything. Clear, he turned. And as his body turned toward the water, his mind followed, thinking ahead to his duties. His cuts and bruises were beginning to hurt, true. But something in the back of his mind was pushing him, something perhaps as powerful as the instinctual desire to join with the harem that chose him as their provider and their protector. It did not make sense to him that humans—even as degenerate as Lord Thet and his gang—would or could suddenly start preying on Do'utians, even given the sort of general philosophical license primitivism in both species seemed to grant. Something less random and more evil was happening. Perhaps Gri'il could help him.

* * *

The Planetary Civilization must be permitted to evolve, and experiments must be encouraged, for only through change is knowledge expanded.

—The Compact and Charter of Planet Trimus, Article 5

Aurum stood high above Ember when Drin returned to the harem beach with his mouth full of fish, and the star had moved a dociradian west by the time he finished the simple duty of placing the fish into throats. Once done, he unpacked the neural interface cap and approached Gri'il.

Even now she hesitated, putting her nose to the beach. Despite everything that had happened, her distaste for this artificiality was evident. But then, apparently recognizing the necessity, she raised her head and came to him. He fitted the cap over her.

"It will take a while to calibrate itself. There will be a bit of a delay to start with, but you'll get used to it. Now, just tell me your name, as if you were whole again. Repeat it until the computer in the cap gets it right."

It produced an intelligible "Gri'illaboda" after about six tries, and she got used to it in a few more. Finally, she could speak through the device more or less naturally.

"OK," Drin said. "I'm going to record this, so why don't we start by having you say who you are?"

"I am Gri'illaboda, co-mate of Drinnil'ib."

Great. Just great. "I am sorry,

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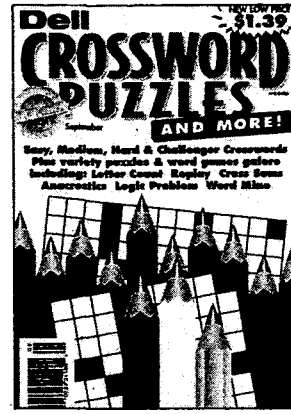

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Gri'il. I am a planetary monitor, and not a primitivist. I care for you, yes— but more as a senior family member, not as a mate."

"You replaced our beachmaster, mated with my co-mates."

"It was not my choice. I did not seek you or them to mate."

She was silent for a few heartbeats. He could hear the waves and the sea birds.

"Drinnil'ib, I was the daughter of Slora'analta and Broti'ilita. Did you know either of those?"

"The historian."

"Who told the old tales of the free seas and made a romantic out of his daughter. I was bored with school. I met a free rover. He took me here, quickened my ovaries . . . then took my tongue."

"Glodego'alah?"

"Never. Glodego'alah was a tourist who saw what had happened, fought the free rover for us, then took us here to be safe. But he paid for his charity in a way that happens all too often here."

"Then I am sorry for what I thought about Glodego'alah. We are seeking the humans who killed him, and four others who were killed. Did you know any of them? Did they have families here?"

"Glodego'alah remarked once that harems change masters easily because of such human predation. Their ships come in the channels between the islands and the ice pack where beachmasters gather fish."

Drin nodded. "I came close to being a victim myself on my way back from my initial investigation. It is easy enough for them—I suspected nothing until they shot at me. I would think someone down here would warn the humans not to do this."

Gri'il huffed in derision. "The sea lords don't interfere. They say the humans take the weak and the race gets stronger, and that the inbred softness of civilization is thus cleansed from our blood. But Glodego'alah was not soft."

"No, I'm sure he wasn't. Who are these 'sea lords'?"

"They are the free rovers, the ones who take from both poles what they want. They live like beachmasters at the south pole, then swim north and have all the luxuries of civilization. They are . . . the human word is hypocrites."

"And if they don't come back?"

"A harem doesn't stay unmastered long here. A sea lord shows up soon enough to claim a missing master's family. They seem to know, somehow, when one isn't coming back."

Her passiveness disturbed him, but perhaps it was simply adjustment. Early Do'utian history wasn't any prettier than early human history. Less so, in some respects. And the Kleth, of course, were cannibals well into their spacefaring days. Drin shuddered, wondering at his fascination with such things. But he had to ask; it might be important.

"Gri'il, how was your tongue to be taken?" Did she just submit to such an amputation?

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"The sea lord who ran off my first mate, said it was traditional. He demanded this after the first mating, then he said he would not take my egg unless I submitted. Also . . . I can't explain. I sometimes feel a need to surrender myself, to let the tides of providence have their way with my flesh. At any rate, I did not resist. In my state at the time, he was God."

Submit to mutilation, or die. Such was her natural paradise. What polluting monster would . . .

"His name?"

"Gota'lannshk." The same ruffian he encountered at Cragen's? Drin hissed in disgust.

"You know of him?"

"We met. Look, Gri'il, will you come back to the North with me? For treatment."

"We are bound to you. I need to stay with you, to submit to you. And I have the eggs, remember? Or are you so civilized that that doesn't matter?"

The eggs probably shouldn't be hatched, Drin thought. Two fathers. No tests. No family. No birth allocation.

"Gri'il, compulsions are subject to medical intervention. My duty is to try to right the wrongs done so far, if I can, and prevent others from being done. Can you get the others to come?" And how many more were there out in those islands. Should they save them all? By force if needed?

"If it is clear that we are leaving, they will come, for whatever good it will do them."

"We'll regenerate their tongues, teach them to speak, send them to school."

"They were hatched out here. Their minds were untrained during the crucial years."

Truly feral. He feared as much. "Still, we have to try. We can find a deserted northern island for your co-mates, and arrange for them to be watched. But what about you? Now that this has happened, can't you see your way back to—"

"To what? We live with the humans and the Kleth on this planet at the expense of ceasing to live like Do'utians, at the expense of always pulling against our own inner nature. And the stars are too far apart for it to matter. I showed my tail to all of that. Say what you want. I lived. I swam in the wild currents. I did it on the beach. You want me to go back to that northern emotional straitjacket and listen to all those proper titters and I told you so's? I'd rather die!"

And her present state was not a humiliation? But her age-old argument, Drin thought, was unanswerable. The civilization of Trimus was for those who thought it mattered.

"We don't want to tell you how to live. I'm sure your privacy would be respected, and protected."

"Like in a zoo! Drinnil'ib, you rescued us, fed us. Don't you want us? Don't you feel the need to own and protect us? Or in the name of your Compact have you let the humans reengineer your sex?"

Drin groaned. He wanted her enough, but he did not *want* to

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want her. At least not as she was now. The whine of fans reached him before he could find a suitable way to explain that. Mary! Relief flowed through him. The aircraft settled on its fans, the hatch popped, and Drin walked over to greet his partner, leaving Gri'il with her beak in the gravel.

But Mary was nowhere in sight.

"Mary?" he called, worried.

Do Tor opened the canopy, jibbered to his machine, and the cargo door popped open. Of course, Drin realized. There was no room in the Kleth cockpit for a human, and indeed, it took Mary a while to unfold herself from the cramped space.

"I'm here, Drin."

"It's good to see you!" He explained about the sea lords. "So I think your human hunters have Do'utian accomplices, at least in principle. But things still don't swim well in my mind."

"The strongest, fastest, or most clever survive. I can see that, I guess. You think the Sea Lords were using Lord Thet to cull their herd, so to speak?"

"That seems to fit."

"Well, Lord Thet's gang of wannabe barbarians seems to be only too happy to help. Your people are the most challenging hunt in the ocean, they probably think."

"Brings up the question of whether we have right to interfere," Do Tor observed.

"To save lives?" Drin protested. "Of course we do."

Mary sighed and gestured to the sky. "Drin, there are now many beings out there who can trace their origins to our home worlds, but who have engineered so much into themselves that they look on *us* as primitivists. They could make a problem like Lord Thet vanish in an instant with no loss of life—but would we want that?"

"Those who didn't get killed might appreciate it."

Mary shook her head. "The parts of our natures that lead to this mess could easily be changed, but then what would we be? Death, even random death, may have a justifiable role in society that transcends individual needs. Perhaps, to keep our identity, we need to learn to accept that."

"I think," Drin asserted, perhaps a little more loudly than necessary, "that such issues should be debated by the planetary council and that *our* job is to not let anyone else get killed until they do and decide . . . whatever. Now, I have four physically mutilated and three of them intellectually mutilated—Do'utian women to bring back to where they can be properly protected and cared for. Let's do that and sort the rest out later."

"Agreed," Do Tor clucked. Mary nodded quietly.

"Gri'il," Drin said, "Is there any way the others can be told of how long a journey this will be?"

"They will follow you if I do," she said, coldly, it seemed. "But the hunters will be watching."

"And the planet will be watching them!" Drin proclaimed. "They won't dare do anything."

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"I will ride with you," Mary said. "In full uniform. At least they'll know what they're playing with."

Drin didn't remind her of how persuasive her uniform and submarine were at Thet harbor.

"We'll fly cover with loud voices and guns," Do Tor said, spreading his wings. "Aircraft can fly itself, so that makes three above."

"Oh yes," his mate chimed..so it was decided. A convoy North.

Drin led the way into the water the next morning with Mary's warm legs and arms comfortably around his neck. They'd fashioned a light glasscloth collar for him that she could grasp and so hold her position in the current of his passage. This was no irritation, but the bulge of an appliance she had constructed to protect her wounded knee was a noticeable reminder of their vulnerability in these waters—many more monitors would be needed to handle Lord Thet and his allies without loss of life.

Gri'il came quietly after him, and as predicted, the harem followed.

It was a fine gray day with favorable surface winds, and light, cooling surface squalls. A brackish current flowed north here from the ice cap on the largest southern island, overlying warmer saline water flowing from an inner pole drainage basin, and so the Do'utians had made good time without becoming overtired.

By the morning of the second day, Lord Thet's domain was well behind them, and they glided through the waves half way into reef-crowded tropical waters. A volcanic island with wide black beaches lay to their left, and a reef to their right, but the channel was fairly deep. Drin was just beginning to relax and enjoy the scenery when the human ships appeared.

"Don't think they're hunters," Do Tor sent. "Big Do'utian male right with them, no shooting."

"Can you describe him?" Drin asked.

"One and three-eighths Charter unit long. Big white crescent-shaped scar behind the blowhole. Do you know him?"

"If it's who I think it is, I've smelled him before. A harem-coveting sea lord with his tail across two beaches. It's time to ask that rogue a few questions."

Gri'il and her co-mates keened as if they were being mortally wounded.

"It sounds like our refugees have smelled him before as well," he continued. "I'd better let those humans know what we're about. Ready, Mary?"

"Gills on." He felt her arms as well as her legs encircle his neck, and her hands grasp the collar. She was secure. He dove and, slamming the ocean back and forth with his tail, headed toward the lead human ship much faster than he could manage on the surface.

About ten Charter units from the hull, he broke water again. So did his harem—he'd forgotten to tell Gri'il to stay back. It shouldn't be necessary, but he was uneasy.

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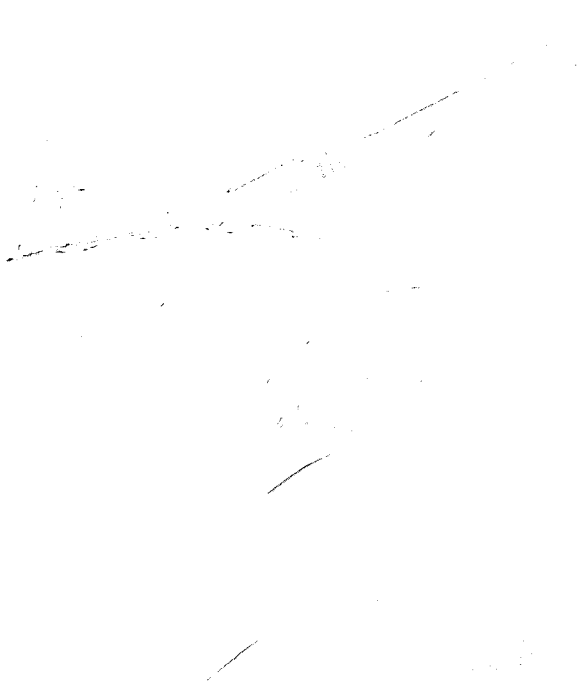

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"Mary, I'm not sure how much comfort we should take from Gota'lannshk being present."

"Why would they shoot at us and not him?"

"Why is there a sea lord always ready to inherit the harem of a victim? Why did Gota'lannshk seem to know that I'd had a close call with these hunters when we met him at Cragen's?"

"Lord Thet—"

"Mary, I don't want to insult your species, but I don't think that idiot has been running this atrocity."

"Huh? Why?"

"Later. I just hope these people have sense enough to keep out of this." Drin inhaled and boomed as authoritatively as he could, "Human ship, we are Planet Monitors escorting citizens on an official mission. We need to ask your companion some questions. Please do not interfere. I say again, do not interfere."

Mary waved at them and smiled.

The report of the harpoon gun reached him first, then Mary's scream and the sharp, deep pain in his neck.

"Look out!" Do Tor yelled over the radio link.

The taste of blood was in his throat. He dove and heard a sharp smack on the water over him. Instinct said to head for the very bottom, but Mary, if she were still alive—he could no longer feel any pressure from her legs—wouldn't survive that. Despite the pain, he pushed water hard and got about eight-squared Charter units away from the ship before he surfaced again.

"Mary?" he called. If those polluting, suicidal, feral idiots had killed her. . . .

There was no answer. Oblivious of his wound, he turned back toward the ship, rage building.

"Do Tor, I can't see behind my head. What's happened to Mary?" Did the Kleth follow him?

"Drin. Long spear in your neck. Went through Mary first, through her leg. Not necessarily fatal wound, but suggest you make for nearest island. Go Ton will go with you. West, Drin, *now*. I've called aircraft down. That ship will not fire again. Go!"

As if to contradict the Kleth, the harpoon gun fired again and the lance slapped the water beside him. He could hear warning blasts from the aircraft and Go Ton squawking at the top of her lungs, telling the human ship to stop shooting. In the name of eternal repudiation, the murderers would pay for this! He started swimming toward the ship.

He felt, more than saw, a Do'utian charge under him directly at the human vessel.

"GRI'IL, NO!" he bellowed hopelessly, much too late.

The impact boomed out, sound reaching him underwater before through the air. Then, beneath, he heard the creaking and cracking of wood and the screams of humans underwater.

"Drin!" Do Tor screamed. "Get to that island, now. I take care of this. I will mark them. They will not

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escape, not melt into primitivist population. I mark. Go, now, save yourself. Save Mary."

"Drin," a soft voice called. "I'm awake. It hurts like hell, but if you have to go back for her, I understand. I can take it."

Reason returned. "Mary. No. I'll have to trust Do Tor." There was no way Gri'il could have survived that impact. No way that he would have. And the eggs . . . it was better that way. Perhaps Gri'il had known that. But his wound had little to do with the effort it took to push himself toward the island.

A whistle and some kind of explosion sounded behind him. Then another. He could hear loudspeakers. Killing for killing—perhaps they would understand *that*. Then, somewhere from the back of his mind, between the currents of pain and grief, a thought formed in an eddy of cold fear. Gota'lannshk had disappeared when the shooting started. To where?

The island was a long swim on the surface and he gagged on his blood by the time he got there. Go Ton was waiting at water's edge, alone, with a med kit that must have weighed as much as she did.

"Come on, just a few steps farther, above the tide line," she urged.

He did that, then he was on his belly, his tail still in moist sand. Go Ton fluttered to the top of his head, out of sight. He heard the buzz of a bone saw, and the shaft of the harpoon soon tumbled to the ground. There was a yelp, quickly stifled, from Mary. Then a numbness started spreading through the wound. Soon he felt as if he didn't know what had happened to him, that all that was wrong with him was a stiff neck.

"Now, Mary," Go Ton said, "I know it looks awful, but I think it best to leave that piece in your leg alone until help arrives. Human aircraft will be here in eight-fourth beats. Might do more harm than good if I try to remove it now."

"I understand," she said, "this sounds ridiculous, but right now I feel OK, except my leg is dead to the world. I'll be all right as long as I don't look at it. Can you help me down?"

"Not alone. Lieutenant Drin, can you lend a tongue?"

His tongue still worked; the barb had not gone in that deeply, perhaps in part because Mary's leg had slowed its entry. He reached back, and between the three of them, they were able to lower Mary down to the sand.

"Where's Do Tor?" she asked.

Pollution! She'd forgotten, Drin realized, and he couldn't warn her with his tongue extended so far.

"He's with the aircraft cleaning up the mess with the human ships," Go Ton responded, shakily. "He should have everything well in hand and be back with us soon."

"You've been too busy helping us to check!" Mary said. "I'll contact him, let him know we made it, and find out how things are."

"Please do not do that," Go Ton pleaded.

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Just a little further, Drin thought. There! Mary was safely down, and he could speak again.

"But, I know how much he means to you—" Mary started, oblivious to the danger.

"That's *why*, Mary," Drin interrupted, "for the sake of providence, think!" The Kleth team had taken the ultimate risk for them, and Go Ton's position was precarious. She would live as long as she believed her mate was alive. But if everything was *not* fine with Do Tor, that would effectively eliminate Go Ton as well. "We need Go Ton just now."

"Oh!" Mary said. Everyone was quiet for a heartbeat. Then Mary continued, her voice with a certain forced steadiness. "Go Ton. Uh, that human garbage doesn't have any weapon that can hurt Do Tor. He'll be fine."

That human garbage shouldn't, Drin thought, have had any weapon that could have hurt him or Mary. But here they were.

"Drin, I am stiff-winged on Do'utian first aid," Go Ton said, firmly changing the subject, "but I think the spear should come out of you now. It is the sort that works its way in deeper every time you move, and without Mary's body holding it back . . ."

"Do it." Before the anesthetic, Drin could sense how close the barb had worked itself toward his central nervous column. He had arteries and blood to spare, but didn't want to stop breathing just yet.

"If you could roll on your side. . . ." Go Ton asked. He complied, then lay silently, feeling little tugs and tears in his flesh and tried to imagine one of Go Ton's tiny thin horny arms deep in his flesh with knives, cutting a passage for the barbed spearhead.

Then the Kleth said: "Mary, need help. The strength of your arms."

Using the discarded shaft of the spear as a crutch, Mary hobbled around behind him, patting him on the beak as she went by.

A little later, he heard her say "oof," felt a sharp pull, and saw Mary fall backward into his field of view again—her arms bloody up to the elbows, her hands clutching the cruel barbed spearhead. Go Ton remained behind him; little tugs and pulls continued for another eight-cubed heartbeats.

"Now that's all closed as well as I can do it," Go Ton said

"Thank you," Drin said, and rolled slowly back onto his belly. "Did the harem follow us here?" The thought of them reminded him of Gri'il. He shut his eyes and let the empty feeling pass.

"Yes, they're huddled together in shallows behind you," Go Ton answered. "They seem very sad, beaks in sand, but are unhurt, I think."

Drin was thinking that Do Tor should have been back by now, and searching his memory for any kind of convention for handling the worst case situation. There would come a point when, if the news were bad, Go Ton would have to be told, and nature would have to take its course. To do otherwise

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would be to not respect the decision her people had made to not change this part of their genetic make up. Perhaps the best thing would be to wait until she asked herself. If....

The challenge roar echoed off the lava cliffs and caught them all by surprise.

In an instant, before he even realized what it meant, Drin's heart doubled the strength of its beats and he could feel the effects of various body chemicals, not greatly different from those that had hit him when he fertilized the feral eggs. That primordial insult deserved an equally primitive response. But he made himself stay still, and without moving his injured neck, he swiveled an eye to the direction of the noise. Far down the beach, a big, scarred male.

"Same Do'utian we saw with the human hunting ships," Go Ton said from above.

"Gota'lannshk," Drin rumbled, in no shape or mood to play primitive beachmaster games. "His beak is dripping with this. Tell that idiot to stay away from us, before I kill him!"

"Drin," Mary whispered, almost inaudibly, "he's bigger than you, and with your wound you'll kill yourself before you get to him. Try to calm down. Think. If he inherited Glodego'alah's harem, and he was connected with the human hunters—"

"*Precisely*, Mary. A lot easier to get Lord Thet's people to eliminate his rivals than fighting for a harem on the beach the old-fashioned way. These murders were no game of survival of the fittest, or even of macabre chance. Those polluting idiot sea rovers carefully selected the hunting victims and no doubt led Lord Thet's ships right to them. Lord Thet probably lost a few selected men as well, just to keep things even, gain birth allocations, and reduce the number of his political rivals." Drin's anger increased. He should turn the murderer into snail meat. His breath came faster.

"So," Mary said, "the whalers get their hunt, their flesh, and think they're just playing by some tough rules. But it's all fixed ahead of time. Premeditated. Drin, stay down, please. Drin? Drin! Give me your gun."

The Do'utian sea rover bellowed again and blind rage started working its way through Drin. The nerve of that cow stealer! He heaved himself to his feet, oblivious of the wound.

"DRIN!" Mary screamed. "Give me your gun! Drin. Your gun! Now!"

In some small corner of his consciousness, Mary's words got through. Somehow, as he began to rock back and forth on his legs, he sent his tongue into his pouch and retrieved the weapon for Mary, dropping it almost absentmindedly on the sand next to her. That popgun was never, he thought with a last wisp of clarity, meant to stop a charging Do'utian.

He got a whiff of the challenger, ripe with arrogance. He heard his

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cows keen and smelled their fright. Dimly, he remembered there were things one was supposed to do in beak-to-beak combat, things that used the opponent's charge against him. Ways to use the tail as well as the head to put the other on the sand, but that all seemed very fuzzy and far away just now. All he wanted was to charge and bite the throat.

Hardly even aware that he was doing it, Drin lifted a clawed front leg, dug it deep into sand, and bellowed. The sun was high; it was a good time to taste blood.

The other began its charge. He stomped forward to meet it. Somewhere behind him he heard a series of sharp, high frequency sounds begin at regular intervals. He didn't care, his body was aflame, producing heat many times faster than he could lose it. He didn't care. It felt good. He felt the wind of his passage build up, giving him some relief. Somehow, both hind legs moved together while both front legs hit slightly apart. The beach shook beneath him. He fixed his eyes on the other's neck, looking for an opening, looking for where the cycle of its charging stride exposed the throat to Drin's beak.

But its neck kept getting lower to the beach. Its charge seemed to become unbalanced and slow. His opponent screamed now in protest and its scent changed from challenge to fear and danger. It keened and shrieked and wavered from side to side.

With the danger call, a bit of consciousness returned to Drin, and he swerved at the last heartbeat, avoiding a collision that could have ripped open his stitched up insides and left him to bleed to death.

The sea lord collapsed into the sand in front him, plowing a furrow two Charter units long with its gaping beak. He passed by the hulk in an instant and into an eerie silence. The bellows and the sharp sounds had ended; only the surf and the thunder of his own mad rush sounded on the beach.

Burning inside, Drin exhaled gales, bent his path into the sea and let momentum carry him into the cold water, sliding forward until it covered him. A very gentle bend of his tail brought his head back to the shore.

The drama was not over. The fallen sea lord groaned and snapped at sand. Its right foreleg was covered with blood and bent at a wrong angle. Its hind legs pushed sand uselessly, trying to propel it somewhere. Then it used its tail to turn itself over, trying to roll to the cooling waters of the sea. Once, twice, it rolled. But, as Drin settled himself into the life-giving cold water, the sea rover stopped rolling. Its tail rose majestically and thudded into the sand. Once, twice.

At the last, it threw its tongue at Mary, falling far short. "Dirty human cow," Gota'lannshk screamed at her. Then . . . nothing.

Heat death.

Drin lay in the shallows panting. Fiery pain shot through him. He could taste his own blood again;

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some of Go Ton's handiwork had come loose. He saw Mary prone, the shaft of the harpoon still projecting bloodily from her leg, her elbows in the sand, his gun in her hands, still aimed at the sea rover. She must have put a hundred bullets in his opponent's knee, but now she shook and moaned. He knew that killing a Do'utian over this was the very last thing she had wanted.

He wished to comfort her, but he was tired. Very, very tired.

His next awareness was of a hotness on his neck. He opened his right eye and looked back. Mary was there, flattened against his neck, gently calling his name.

"Mary," he managed to say, as softly as he had ever said anything, "I'm awake. I'll be OK."

She was apparently having trouble breathing, but turned to his eye and said, "Oh, Drin. Oh, Drin. It's—it's so hard to get my arms around you." Despite her appearance, he somehow knew she was happy.

Noise and smell intruded. The sky over the island beach was filled with both aircraft and Kleth. The death smell of Gota'lannshk was there, among the smell of many beings, and the sound of many voices, Kleth, human, and Do'utian. He recognized Do Tor's and Go Ton's among them, and took a ragged but deep breath of satisfaction. Everyone had come through, and, like rational, civilized beings, they were all discussing what was to be done next. ■

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Doug Beason

AMERICA'S BLUEPRINT FOR MARS: THE REPORT OF THE SYNTHESIS GROUP

Illustration by Alan B. Chinchar

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On July 20, 1989, on the steps of the National Air and Space Museum, President George Bush gave a speech commemorating the 20th anniversary of the landing of the first men on the Moon. In this speech he outlined an exhilarating national goal—for humans to return to the Moon, this time to stay, and then to go to Mars *and beyond*. This marked the first time since John F. Kennedy's speech that America was challenged to "go where no man has gone before."

For all intents and purposes, the nation had pulled out of exploring space at the end of the Apollo era. Human presence was limited to a mere few hundred kilometers from the surface of the Earth.

However, if properly instituted, this new challenge could define a renaissance for exploring the Universe.

In response to Bush's speech, NASA conducted a "90 Day Study" that laid the groundwork for achieving the president's goal. The next step was taken by Vice President Dan Quayle, as head of the National Space Council. Determined not to continue business as usual, he directed NASA to establish the Outreach Program to "cast nets widely" for new approaches to accomplish SEI, the Space Exploration Initiative. The Outreach Program was initiated as a nationwide hunt for the best ideas on how to send humans to Mars, cheaper, faster, smarter.

Astronaut Tom Stafford—*Gemini* pilot, *Apollo X* commander (where he brought the lunar module to within kilometers of the lunar surface) and pilot of the *Apollo/Soyuz* mission—was asked by the vice president to establish a *Synthesis Group*, responsible for pulling the Outreach program together. Stafford assembled a group of 46 experts hailing from all walks of life—academia, industry and government—after receiving nominations for his group from industry heads, cabinet officials, and professional societies. He also included 23 senior members consisting of internationally acknowledged space leaders, ranging from a former secretary of the Air Force, to the designer of the *Mercury*, *Gemini* and *Apollo* spacecraft. Once convened, the Synthesis Group was tasked to achieve three goals: to analyze and synthesize the thousands of Outreach responses, to recommend two or more significantly different architectures for the Space Exploration Initiative, and to identify technological priorities and early milestones to land humans on Mars.

The Synthesis Group report has been widely distributed, briefed to Congress, and its ramifications are still being debated throughout academia, industry, and government. The report provides a vision of America's future in the exploration of space. This article will concentrate on the rationale of why specific recommendations were made and how they will affect America's space program.

The crux of the Space Exploration Initiative is to pursue the peaceful application of high technology. With a goal of reaching Mars, this will inspire and invigorate generations to come. And when combined with technical spin-offs, the increase in scientific knowledge will add to reestablishing national leadership. There are certainly dozens of ways to reach Mars; some of them,

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such as Zubrin and Baker's *Mars Direct* concept, have appeared in *Analog* (July, 1991). However, the Synthesis Group has assembled more than just a mission to the red planet. They've drawn up blueprints for invigorating the nation, just as *Apollo* did in the sixties.

But before the results of the Synthesis Group are presented, two questions brought by critics should be addressed: why bother exploring space, and why now?

The obvious answer is that SEI provides a focus not only for our space efforts, but for the nation as a whole. It allows us to invest in our nation's scientific and technological base, creating new job opportunities and markets; arguing to go to space for "Teflon and Tang" simply won't hack it anymore.

More directly, SEI provides the chance to reorient our GNP from being fueled by the military-industrial complex to being based on that of a space-faring nation. This is especially critical during these post-Cold War days, where America needs a stimulating national goal on which to base its economy.

SEI has the opportunity to facilitate the commercialization of space and promote space-based industries, products, and services. In fact, one of the architectures developed by the Synthesis Group concentrates on using space resources for just these purposes.

Further, SEI allows for advancing technological innovation. This means spurring new technologies with terrestrial and commercial applications. This in turn will inspire interest in science and engineering.

The consequence of investing in space is to radically increase our knowledge of the Universe. This will help us better understand the origin of the Universe, planets and perhaps life itself.

These are all good reasons for establishing a space exploration policy. But still the question remains, why should America do this now? Why can't we wait until times are "better," economically as well as socially? After all, it's pretty hard to justify sending a few people to Mars when there are plenty of people hurting right here at home.

Part of the reason has already been given—SEI is a fundamental way to ensure that those better times will come. It's more than just sending people to another planet. Rather than simply dumping money into the hands of bureaucrats, "experts" in redistributing wealth, it provides for a systematic way to rebuild America's infrastructure. In the 1940s, after World War II, America invested in the future of its past adversaries, Germany and Japan, through vehicles such as the Marshall Plan and MacArthur accords. Some may say that looking back, this was not such a bright idea, but there is no doubt of the success these programs have had in rebuilding those nations' infrastructure.

America is in a similar situation today. But this time we have the chance to invest in *ourselves*, to rebuild the very backbone that defines our nation's economic strength.

And there are other compelling reasons.

The SEI is more than an exploration program; it embodies the essence of a new social paradigm and it is therefore constructed without limits. This is different from saying that "no end is in sight." Rather than having a closed goal

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of only getting humans to Mars and ending the program there, SEI uses education as a basic priority to bring out the very best in our nation, and to hold the future open for our children. It is forward-looking and will focus technologies to allow this social effort to succeed. (Compare this to what happened to the *Apollo* program: once we got to the Moon, the public lost interest and the space program went downhill.)

The SEI provides a focus to the entire space program. Just as *Apollo* succeeded in the 1960s, SEI can unify our future goals in space.

The Moon and Mars are the first elements of an exploration program. The Moon provides a natural platform for astronomy, planetary science, and even as a resource for materials and energy. Since it's only 240,000 miles away from Earth, it's a logical first step for getting to Mars. With a surface area of 14.6 million square miles—roughly that of Africa—it provides a unique test bed for checking out equipment and procedures while being only three days away.

In addition to the fact that Mars might someday be a habitable colony, the opportunities to explore this pristine planet can reveal myriad facts about Earth—through geologic evolution, how the atmosphere and climate has changed over time, and even by searching for fossil life. This would be perhaps the most far reaching discovery of all: if true life is found to have existed on Mars, the societal implication back on Earth will have enormous ramifications.

The mere task of getting to Mars is much harder than simply fielding a test bed on the Moon and then rocketing out to the fourth planet. The differences between the Moon and Mars are vast. Everything from the presence of an atmosphere to radio delay times of up to 40 minutes will bring unique challenges. As such, any architecture for SEI must be diverse, robust, and flexible.

To define the architectures, the Synthesis Group established the concept of *Waypoints*—specific objectives to be achieved on the surface of the Moon or Mars. The architectures were then comprised of a linear combination of these Waypoints. This allowed the group to configure a set of architectures that gives policy makers a wide choice in how they accomplish SEI's goals.

The Waypoint concept required a radical change in thinking for mission scenario planners. Rather than approach the science community and ask what *they* need to get to Mars, Waypoints place the burden of work on generating *requirements*. That is, once a specific goal was defined on the surface of the Moon and Mars, then a scientific framework was built up to achieve those goals.

This prevented everybody from going out and trying to add their two cents to the project. "Hobby shopping" and parochialism were stopped, since the important goals *on the surface* had already been defined. The questions then turned from asking "What do I do once I get to Mars?" to "I have a specific goal to accomplish on Mars, so tell me what type of infrastructure I need to support this requirement." The difference may seem slight, but the results—and the costs needed to accomplish it—are dramatically different.

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SYNTHESIS GROUP WAYPOINTS

- Lunar observation
- Habitats
- Using the Moon as a test bed for Mars
- Resource utilization
- Lunar exploration
- Nuclear/chemical option for Mars

The Waypoint concept helped the Synthesis Group zero in on the methodology for setting up different architectures. The group constructed four architectures to fulfill their charge. The architectures satisfy the requirements for establishing an exploration program and were purposely made different so that policy makers could fund any one of them, depending on the major goals they wished to accomplish. Further, once an architecture is chosen, then a cost can be calculated for following that path.

The Synthesis Group was attuned to the wishes of myriad organizations that either sent briefing material, or had teams of experts come and present their ideas to the group. Some organizations had a clear-cut agenda: get to Mars as soon as possible (sometimes even bypassing the Moon). Every one of the fifteen hundred suggestions received by the Synthesis Group was reviewed and taken into consideration. The following architectures reflect a consensus of the group.

Architecture 1: *Mars Exploration*

This architecture is the classic "flags and footprints" mission. It achieves the basic SEI goal of landing humans on Mars by 2014. In addition, its main strengths include exploring Mars and accomplishing good science. In this and the following architectures, the human missions are preceeded by a cargo mission. The philosophy of splitting up the cargo and human missions is called a "split sprint" concept. That is, the cargo is sent on an energy efficient (minimum energy) Hohmann transfer orbit, taking as long as 1,000 days to reach Mars. Since there are no humans on board, there is no reason to minimize transit time. Once the cargo ship has successfully been inserted into an orbit around Mars, then a fast, or "sprint" mission with humans may be launched to rendezvous with the cargo ship. The human mission is thus relieved from carrying the enormous amount of fuel and supplies needed for a Martian descent.

The piloted craft is sent to Mars in a "free return" trajectory—if for any reason the engine in the Mars Transfer Vehicle (MTV) does not ignite as the spacecraft approaches Mars, the MTV will use Mars in a gravity assist to return to Earth. (It goes without saying that the MTV carries enough supplies for this scenario.) The obvious drawback to this plan is that if the spacecraft approaches Mars too fast, it will have too much energy to allow the free return. This sets an upper limit on the MTV velocity and thus a lower limit on the transit time, an important parameter in the priority hierarchy discussed later in this article.

The initial Mars mission will involve a 30-day stay on the surface, with a 600-day stay planned for a subsequent mission. Prior to the first Mars trip, all architectures use the Moon as a test bed for Mars to check out critical components in a full "dress rehearsal."

Architecture 1 will use common sys-

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tems and operational techniques between the Moon and Mars missions to the maximum degree possible. The reasoning is two-fold. First, this ensures that everything is fully tested in an environment "not too far from home." The unusual success of the Apollo program was based on the philosophy that *everything* should be simulated as accurately as possible ahead of time—surprises were not to be tolerated. A good analogy exists when buying scuba equipment: it's wise to test our your tanks in a swimming pool before heading out to the ocean.

The second reason for using common systems is cost: it's cheaper *not* to develop separate systems for the Moon and Mars if the same system can be used. So in many ways, this is a minimum-criteria mission that will satisfy the president's goal. However, a drawback to this architecture is that since a minimum investment is made, there is a possibility that long-term support may dwindle.

Expeditionary missions will precede any permanent outpost on Mars. Timelines for this architecture are to land the first 5 person mission on the Moon in 2005 for a stay of 14 Earth days. Three additional lunar missions are planned with increasingly longer stays, until a training mission for the Mars flight occurs in 2009. Two additional flights are held in reserve if additional validation of equipment is needed.

Architecture 2: *Science Emphasis for Moon and Mars*

This architecture takes full advantage of the Moon and Mars to increase our knowledge of the Universe. It consists of a balanced science program and emphasizes exploration.

Pressurized lunar rovers, especially fitted for long duration missions of up to two weeks, can roam 50 kilometers from base, increasing to 100 kilometers on later missions. Mini-telerobotic prospectors, perhaps piloted with virtual presence technology, can greatly add to the exploration. On the lunar surface, these prospectors may even be commanded from Earth. The 2.5 second round trip light delay is not enough to preclude direct interaction with Earth researchers. On the other hand, on Mars the light delay will run from 10 to 40 *minutes* each way, depending on the relative positions of the planets. This will result in a radical change of command and control philosophy. No longer will the astronauts be required to clear every activity with mission control. Emergencies won't wait for light delays.

As an example of the science program, an optical interferometer on the Moon with arms kilometers in length may be able to achieve resolutions on the order of a microarcsecond—over a hundred thousand times greater than what the Hubble telescope was designed to resolve. With resolutions this small, it is not only possible to detect Earth-sized planets orbiting nearby star systems, but to make interferometric studies of those planets' atmospheres (for example, we can tell if the atmosphere holds oxygen and other life-bearing constituents).

Compared to the Earth there is a *million times* less seismic activity on the Moon. The Moon is thus a near perfect place to put sensitive astronomical equipment such as the optical interfer-

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ometer.

As another example, an entire part of the electromagnetic spectrum is forever hidden from observation on Earth because of the ionosphere's plasma frequency. A submillimeter interferometer on the Moon would open up an incredible opportunity for observations in this frequency region. In an even lower part of the spectrum (megahertz), a Very Low Frequency array on the lunar farside would be shielded from the interference of electromagnetic noise from Earth.

As yet another example, low energy charged cosmic rays are prevented from being directly observed on Earth because of the Earth's magnetic field. This is the "geomagnetic cutoff": low energy particles follow helical paths around the Earth's magnetospheric field lines and are eventually "funneled" into the poles. The absence of a magnetic field on the Moon allows for a "pure" measurement of both the direction and energy of these particles, giving insight into their origin.

There are a plethora of instruments that benefit from being based on the Moon, even when compared to stationing them in Earth orbit. For example, thermal stresses on the instruments, gaseous impact ionization, debris, obscuring multi-spectral radiation, and atmospheric drag are all serious drawbacks for basing astronomical instruments in low-Earth-orbit when compared to the lunar surface. Higher orbits have problems as well, including Earth blockage, stability, pointing and tracking, and ease of access. All in all, if SEI develops as an ongoing program, the science return could be (sorry!) astronomical.

Timelines for this architecture are to land the first 5 person mission on the Moon in 2003 for a stay of 14 Earth days. Several additional lunar missions with increasingly complex astronomical equipment are planned with longer stays, until a training mission for the Mars flight occurs in 2008. A 600-day Mars mission, the first of several, is planned for 2014.

Architecture 3: *Moon to Stay and Mars Exploration*

Along with sending humans to Mars, this architecture fulfills the president's goal of establishing a permanent, albeit initially small, human presence on the Moon. More importantly, this is the architecture that will expand mankind's presence in the Universe. It's the first step in setting up a self-sufficient colony.

As with the other architectures, the lunar colony will use the Moon as a test bed for exploring Mars, putting into operation as many Mars systems as possible. In addition, it will accomplish a small amount of science and exploration on the lunar surface.

The main thrust of Architecture 3 is still to explore Mars by making a concerted effort to study geological features, search for fossil life, and to make a detailed study of Mars. But the most exciting aspect of this architecture is that if humans are ever going to go to the stars, if they are ever going to take that first step in colonizing the planets, *this* is the way to go. This doesn't mean that the other architectures won't result in colonies—rather, this is the architecture that explicitly states that as a goal.

Timelines for this architecture are to

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land the first 5-person mission on the Moon in 2004 and set up a man-tended site for a period of 14 Earth days. Additional lunar missions are planned, increasing the number of inhabitants to 18 with a yearly rotation of 6 crew members. As in the other architectures, a training mission for the Mars flight is planned with a 600-day Mars mission in 2014.

Architecture 4: *Space Resource Utilization*

This architecture emphasizes the maximum, early use of extraterrestrial resources to support exploration. The ultimate goal is to explore the Moon and Mars while solving such problems on Earth as the greenhouse effect, depletion of the ozone layer, and the dwindling supply of finite (and "dirty") energy sources. This architecture will allow us to meet our energy problems head-on.

The Moon could provide energy for the Earth in the form of helium-3—a fusion energy source created in the Sun, swept away by the solar wind and adsorbed into the lunar regolith (dirt). Helium-3 is an especially attractive form of fuel, since it produces no neutrons as a by-product of the fusion process. The charged particles that are created may be easily directed away by magnetic fields. Thus, helium-3 can serve as a "true" non-radioactive energy source.

There is very little helium-3 on Earth, so with the relative abundance found on the Moon—over 1 part per billion—it makes sense to extract it from the regolith once mining technology has matured. And allowing time to gear up for full-scale helium-3 mining, this fits in well with the Department of Energy's forecast of having a working commercial fusion reactor by 2025. An estimated 25 metric tons of helium-3 per year is needed to supply the entire world's energy demand.

In addition to mining helium-3, solar cells manufactured on the lunar surface for use in space would be cheaper than lifting the cells off Earth. This results from the need to overcome Earth's gravity well and lift the solar cells into low-Earth-orbit. Lunar regolith could also provide volatiles for propellant, oxygen, water, and even building material for use on the Moon or in space.

The initial plan for this architecture is to demonstrate that it's feasible to process regolith and extract volatiles. Commercializing these products would be thrown open to the free market once the demonstration has been made. For example, it could also be possible to allow the public to take part mining the lunar surface via an interactive telepresent link using high-definition TV. How many people would stand in line for more than an hour at an amusement park if the telepresent "ride" on a lunar mining vehicle included accelerometers to simulate motion—such as the popular "Star Tours" ride at Disney World?

Timelines for this architecture are to land the first 5 person mission on the Moon in 2003 for a stay of 14 Earth days. Additional lunar missions are planned, increasing to 180 day stays in which a demonstration mining plant is working on the lunar surface. A 600 day Mars mission is planned for 2016, allowing time to accomplish the lunar mining goals.

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Priorities

Safety of the crew was unanimously determined to be the number one priority. It just wouldn't do to land on Mars, only to have one (or more) of the astronauts have a fatal accident. This dictum of "Safety First" is just as true for SEI as it was for the *Apollo* program.

Back in the 1960s, the *Apollo* program had a specific goal of putting a human on the Moon in a decade. SEI's goal is much longer term, with considerably more fiscal and social pressure. As such, apart from the top priority of ensuring crew safety, the remainder of the priorities have changed. It's a more circumspect world, and political realities dictate the changing order. It's instructive to compare these priorities:

Apollo	*SEI*
•Crew Safety	•Crew Safety
•Schedule (land by 1969)	•Cost (don't break the bank)
•Performance	•Performance
•Cost (doesn't matter)	•Schedule ("go as you pay")

As noted, crew safety is paramount. Launching the crew into low Earth orbit is the first part of a series of highly dangerous activities which includes: the flight to Mars, engine restart for insertion into Martian orbit, descent to the Martian surface, surface activities on Mars, ascent back to Mars orbit, engine reignition for the trajectory back to Earth, capture to Earth orbit, and landing on Earth. These are only the major parts of an extremely complicated mission.

The Synthesis Group identified fourteen high-priority supporting technologies that would enable the SEI to be successfully completed. The top two technologies (Nuclear Propulsion and Heavy Lift Launch Vehicles) have a direct impact on the number one program priority: crew safety. They are "long poles in the tent," aptly named because if these long poles were removed, then the entire "tent" of SEI would collapse.

The two technologies also directly affect another critical parameter: minimizing the transit time to Mars.

The transit time needs to be minimized to reduce the zero-G effects on human physiology. We can't expect the crew to spend three or more months weightless, then descend and work in a gravity well. Besides having no one there to take care of them, *anything* could go wrong. Furthermore, experience with astronauts and cosmonauts shows that even three hours of exercise a day does not adequately compensate for the debilitating effects of zero-G. Some argue that building a system to induce artificial gravity would circumvent these effects, but the cost of the system needed to attain artificial gravity is prohibitively high. (I'm disregarding arguments of using tethers purely for safety reasons.)

Besides the weightless effects, there are dangers associated with cosmic radiation. Two centimeters of aluminum shielding will stop some of the primary solar cosmic rays; however, cosmic rays will produce a "shower" of particles during the interaction with aluminum. The shower can be absorbed by

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several centimeters of paraffin, and if the crew's water supply is placed adjacent to the paraffin shield, 16 centimeters of water will absorb the remainder of the shower as well as any other solar cosmic radiation.

The *galactic* cosmic rays are the real problem—they would not be stopped by anything except a prohibitively high amount of shielding; however, NASA estimates that the maximum radiation dose due to galactic cosmic rays, although higher than desirable, would still be less than its maximum allowed limit of 50 rem.

A third danger associated with long transit times is the least studied hazard of all—the psychological damage that might be incurred when humans are in deep space, *really away* from their planet of birth, for the first time in history. Because of these, and other compelling reasons, the need to shorten the transit time to Mars is paramount.

Nuclear Propulsion

Chemical propulsion engines are limited to a maximum of 475 seconds of specific impulse. When included in a multidimensional analysis of mass to low-Earth-orbit, cost, available flight windows and transit times to Mars, using nuclear propulsion is clearly superior to chemical propulsion by nearly a factor of two. The Synthesis Group included an exhaustive bibliography detailing the rationale for using nuclear thermal propulsion, specifically piggybacking on the work performed at Los Alamos in the 1960s on the NERVA program. Current technology can yield specific impulses of 925 seconds using thermal nuclear propulsion.

I'm not going to argue either side of the nuclear issue (see the novel *The Trinity Paradox*, by Kevin Anderson and me, for that). However, if the nuclear reactor is not activated until it is in a "nuclear safe orbit" (defined as over 500 miles above the ground, so that it's in a 10,000 year stable orbit), organizations such as the Federation of American Scientists have endorsed using this concept for going to Mars.

Nuclear electric engines, although having a much higher specific impulse, do not produce anywhere near the thrust as nuclear thermal engines. But they do offer an extremely efficient way to send cargo on interplanetary trips. Instead of using hydrogen as a propellant, neutral plasma is ejected from the spacecraft. This creates a very low acceleration that can work over many months. A hybrid system, employing both nuclear thermal and electric propulsion, may be possible several years in the future.

Heavy Lift Launch Vehicle

Contrary to popular opinion, putting things together in space is not easy—especially in a space suit, and especially if you have to suit up and perform this activity many times. Ask any astronaut—they'll tell you that spending up to four hours pre-breathing (and another four hours post-breathing), getting the skin ripped off their knuckles from ill-fitting gloves, and the sheer strain of extravehicular activity, is not the way to do business.

Axiom: make spaceflight as simple as possible.

With this as a guideline, the Synthesis Group strongly recommended using a Heavy Lift Launch Vehicle (HLLV) to get the most mass possible to low-Earth-orbit, and thus minimizing putting things together in space. This not only drives down the cost, but it also

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keeps the interfaces to a minimum. To accomplish this goal, they urged using the most robust and simplest engine possible.

One option is to use an updated engine based on Saturn V technology; however, the old liquid oxygen/kerosene F-1 engine has a relatively low 281 second specific impulse. Even so, all 13 Saturn V flights, using a total of 65 engines, have been successful. Another option is to use the engine being designed for the National Launch System, a joint NASA and Department of Defense program.

Whatever engine is selected, it must help power the first stage of an HLLV having a 150 to 250 metric-ton capacity to low-Earth-orbit. This much mass would greatly simplify space operations, decrease the cost of the infrastructure needed to launch the mass, and provide a more robust means of getting the mission off the ground.

Conclusions

Since the Synthesis Group report has been released, NASA has appointed Dr. Mike Griffin, formerly Deputy Director for Technology of the Strategic Defense Initiative and a long-time space researcher, to head up the Exploration Office. Dr. Griffin has assembled an impressive team of space experts and is aggressively pursuing a program based on the recommendations of the Synthesis Group. Further, the president has established a multi-agency organization to accomplish the SEI. The Departments of Energy and Defense are joining NASA in pursuing this national goal.

The president has stated that the long-term goals for space exploration are the Space Exploration Initiative. The nation is truly at a threshold—and not a crossroads. A crossroads implies that there exist more than one choice that the nation can make if it is going to flourish; a *threshold* correctly suggests that *there is no other choice*.

The Synthesis Group's vision for the 21st century includes a strong relation between science, technology, and manned and unmanned exploration. This vision compliments NASA's current Mission to Planet Earth and bases its success upon excellence in education. The Synthesis Group believes this initiative should be the centerpiece of the nation's space program.

More importantly, they believe that the nation can't afford *not* to do it. As the group so often stated during their year-long tenure: "We must make the decision to either lead, follow, or get out of the way."

The bottom line is that if we're going to survive, we *must* go down this path.

The majority of this article was taken from "America at the Threshold," the report of the Synthesis Group, available from the Superintendent of Documents, US Government Printing Office, Washington DC 20402.

The views and opinions expressed herein are solely those of the author and should not be construed in any way to be those of the US government.

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A member of the *Synthesis Group*, SF writer Doug Beason holds a Ph.D. in physics and has had six novels published (three of them with Kevin J. Anderson), several dozen short stories, and over fifty scientific journal articles. He currently works at the White House Science Office. ■

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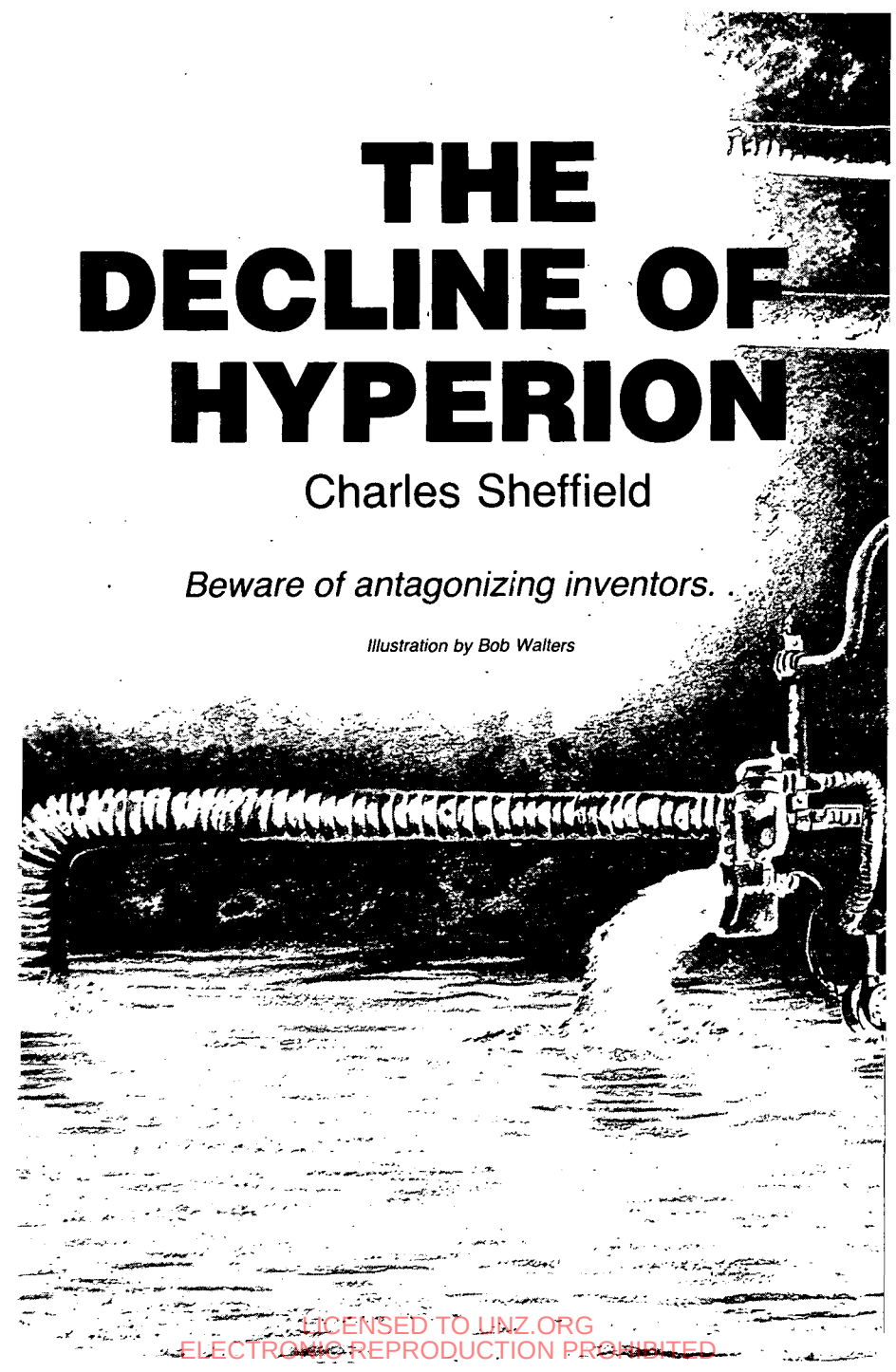
THE DECLINE OF HYPERION

Charles Sheffield

Beware of antagonizing inventors. . .

Illustration by Bob Walters



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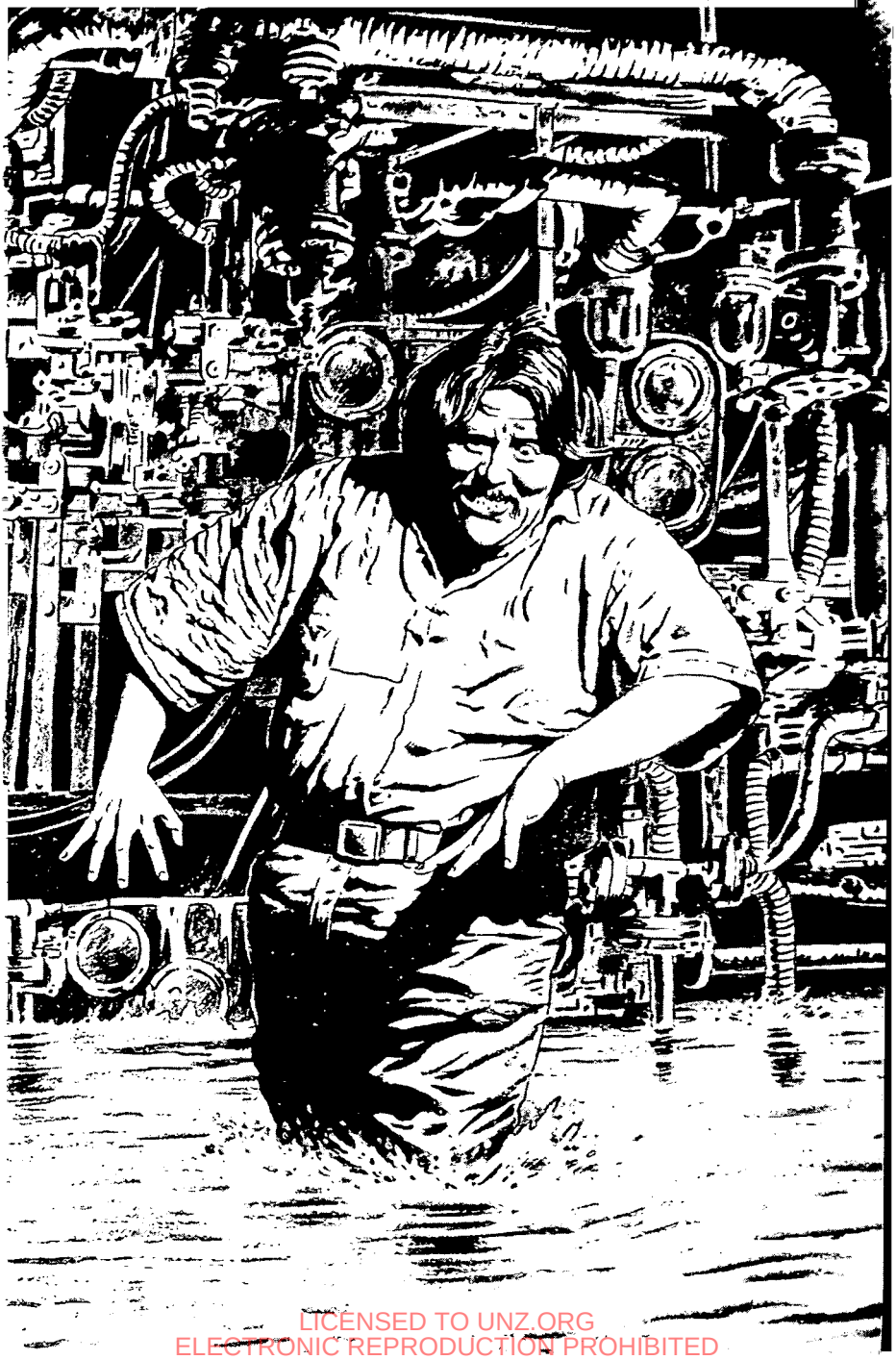

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The medical and legal professions are similar in many ways, but they differ in one important respect. It is this: while lawyers generally derive most benefit from a client in the lusty mainstream of middle life (divorce, mayhem, and other pleasantries), or after its close (probate), the physician is most concerned with first and last years. After the age of four or five and until we are ready to shuffle off this mortal coil, doctors do not see as much of us as they would like.

These thoughts were prompted by the arrival at our law offices of my friend and partner, Waldo Burmeister. He had on his fat face the look of a man who has seen great troubles, and is all set to talk about them.

"All done?" I said, hoping to end it there. I knew that he had been going through a complete physical, in which the medical fraternity had explored in impertinent detail all aspects of his life, from everything in his diet to other far more delicate physical elements. As Waldo said, he was being examined "from soup to nuts."

The proximate cause of the medical exploration was simple. Waldo, a few weeks earlier, had mistaken a powerful explosive for a coffee sweetener. The story of the discovery and subsequent loss of Pintonite has been told elsewhere, a long time ago in a GALAXY far, far away, and I will not repeat it here. I will say only that, since a fraction of a gram of Pintonite could do as much damage as a quarter of a ton of regular explosives, Waldo's interior had been examined to a fare-thee-well. He had been through a lot, and *vice versa*.

"All done?" I repeated.

If I hoped to divert the flow, I was to be disappointed.

Waldo leaned forward indignantly in his chair. "Do I look like a balloon?"

Silence was the only diplomatic answer.

"No, I don't," he went on. "But do you know what they just did to me? They took this hollow tube thing, with a pump attached, and they stuck the other end up my—"

"Excuse me," said an unfamiliar voice. "Am I interrupting?"

Not so far as I was concerned. Waldo and I turned together to face the newcomer at the door of our suite.

He was a burly, angry-looking man in his mid-thirties. He also had a look of nagging familiarity, but I could not place him. Anyway, he was dressed in the black loose-fitting garb of a Hyperion miner, with his swagbag slung over his shoulder. I knew no one from Hyperion. Neither, to my knowledge, did Waldo.

"Not interrupting at all." I stood up and waved him in before Waldo could disagree.

"Good. Because I need help—legal help. My name is Norbert Knox. With a K."

"Henry Carver. With a C." We shook hands. "And this is my partner, Waldo Burmeister. Legal help is exactly what we can provide."

"About fees—"

"All in good time. First, let us hear your problem." I steered Norbert Knox to a chair. "Coffee?"

"Sure." He unslung his swagbag, took out a square box, and sprung it open. "And you help yourselves."

It was full of cookies, of all shapes

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and sizes. I moved the container closer to Waldo. I was not in the least sorry to see it. Only the day before he had been bemoaning his increasing girth, and I had been honest enough to point out that there was a reason for it: he ate all the time.

He denied it, outraged. He was not a big eater. He was a moderate eater, even a *light* eater.

We had made a wager. He would lose fifteen pounds in fifteen days. If he succeeded, he would own my upholstered easy chair, which he had long coveted. If he failed, his skull of Saint Sebastian as a child would be mine.

I was glad to see Waldo blissfully consuming sugar cookies as Norbert Knox gulped his coffee and glared around him.

"I've been robbed," he said at last.

A disappointing start.

"Mr. Knox, we are not in the business of hunting down and recovering stolen and missing property."

"It's not missing, and you don't have to hunt it down. I know exactly where it is."

"And you own it?" It is nice to get these details out of the way at the outset.

"Yes and no. That's the trouble."

Perplexing. "I think you had better start at the beginning."

"Right. When I was a little baby—"

"Not quite that near the beginning."

"Well, let me just say that I was taken to Hyperion when I was young, and I've lived there ever since. You ever been to Hyperion?"

Perish the thought. But we were badly broke, and Norbert Knox was moving on without waiting for an answer.

"It's a nice place to live, Hyperion is, but all the food supplies for the Saturn moons come out on a Jupiter swingby, so nothing's fresh. Sometimes you get space mold, and sometimes solar sizzle, and sometimes there's a funny smell that nobody can explain. Well, I'm a man who likes his food. A couple of years ago I got sick from eating a batch of moldy walnuts, and I decided to do something about it."

"You left and came to the Moon?"

"Naw. I only got here yesterday. What I did is, I built the Knox Converter."

"I thought you were a miner."

"I was a miner. I *am* a miner. You see, that's part of the problem. I built the Converter in my spare time, like."

I was beginning to get a glimmer of where he was heading. "This Converter of yours, Mr. Knox. Tell us about it."

"It makes food. Delicious, fresh-tasting food, nothing like the stuff that usually lands on Hyperion. See, my Converter is an organic reprocessing plant. It starts with raw materials. Wastes. And it makes them into food."

"Raw materials?" Waldo entered the conversation for the first time. He had been too busy eating to speak. "Wastes?"

"That's what I said." Norbert Knox stared at Waldo, whose jaws were still moving. The cookie box was already half-empty. "*Human* wastes, Mr. Burmeister. Sewage. There's other words for that, if you want it spelled out."

"Not at all." Waldo was no stranger to such phenomena, though there was no way that Norbert Knox could have known it. "So you made your processor, and you wanted to use it. But the

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authorities on Hyperion would not give you permission, and they confiscated it."

"It's a lot worse than that. They say they *own* my Converter. You see, I have an employment contract as a miner, and it says that any invention I make while under contract belongs to the company. But it doesn't apply to what I make in my spare time. Only *they* say that I built the Converter on *their* time. And I didn't. I built it on my time. Those lying, cheating swine! Those—those—"

He went on to describe his employers in less than flattering and assuredly libelous terms, that I would rather not repeat.

Knox's face had turned red with rage as he spoke, but at last we were on familiar ground. I could cite a score of precedents for similar employee-employer disputes for inventions. None directly applicable to Hyperion, of course—as they say, civilization ends at Ceres—but such fine points are what make a lawyer's life so full of fun and profit.

"Where is the Knox Converter now?" I asked.

"On Hyperion, last I saw it, down in the Deep Vault there."

"And your employers are using it themselves?"

"They would if they could, but they can't." Knox's face took on its first expression of satisfaction. "For one thing, I added a secret disabling command in the user sequence, one that makes it look to anyone who doesn't know the trick as though the Converter's not working at all. And anyway, the input supply of solid waste needed replenishing. When I left I put an 'Out of Ordure' sign on it."

Knox grinned, and Waldo guffawed. It doesn't take much to amuse him.

It seemed to me that the authorities on Hyperion were more likely to be impounding the Knox Converter, to prevent its nauseating products being inflicted on an unsuspecting populace, than they were to be stealing it. But that line of thought led to no client, and we needed one badly.

"Mr. Knox, do you have a copy of your employment contract with you?"

"I don't." Norbert Knox scowled, again with that unsettling familiarity. "See, I wasn't quite honest with my bosses when I left Hyperion. I said that I was going back to Earth, to look up a few long-lost Knoxes. That's true enough, in a way. That's where I want to go, once I know if there's anything you can do for me."

There might be. But Norbert Knox was a Hyperion Deep Vault miner, and that did not suggest wealth. If we were to represent him, how could he possibly pay us?

There was only one answer. His chief asset was surely the Knox Converter. We could represent him on an expenses-plus-contingency basis, with some fractional ownership of the Converter assigned to Burmeister and Carver, Attorneys-at-Law, upon his rights being established.

And that left only one more question. Did the famous Converter work, or were the products that issued from it edible only in the mind of its creator?

Great minds think alike. Waldo was ahead of me. "Mr. Knox," he said, "before we proceed further with your case we must confirm one thing. You

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say that the Knox Converter makes 'delicious' and 'fresh-tasting' food. Now, it has been my unfortunate fate to sample reprocessed food products on other occasions, and 'delicious' is certainly not the word that comes to mind to describe them. Can you give us some guarantee that the output of the Knox Converter is in fact *edible?*''

''I don't need to give a guarantee. You already have one.'' Norbert Knox pointed to the half-empty box in front of Waldo. ''Those cookies you've been eating were made by the Converter, from the rawest and most horrible sewage you could ever imagine.''

His answer was, to me at least, wholly satisfying and persuasive. Waldo, from the expression on his face, was rather less happy about it.

By the time that Norbert Knox left, we had the basic elements of a deal worked out. There was only one major snag.

Waldo put it into words. ''If you were to take him into court, and he used language like that in front of the judge. . . .''

I nodded. Knox would be thrown out in a moment. Just as bad, he was the last person in the world to have around during a delicate and subtle negotiation. He might be a first-rate miner, and an excellent inventor, but he was too close to his own brainchild to keep his head during an argument. He began to explode every time he thought of what was being done to him. We would much rather negotiate with Knox back on Earth. And yet he had to be there on Hyperion, as the aggrieved party.

I could see no solution to that, until Norbert Knox was gone, and Waldo, turning to me, said, ''Funny looking fellow, isn't he?''

At once I had it—the explanation for that puzzling familiarity, and the answer to our problem. Add twenty-five pounds to Norbert Knox, shorten, straighten, and lighten his hair, shave his moustache, and change his eyes from brown to blue. Hey presto! You would have Waldo Burmeister, to the life.

It would work both ways. My partner could become Norbert Knox.

I decided to say nothing to Waldo until I had a chance to discuss the matter with Norbert. I thought that he would be the one more likely to object. But not at all; for when he called me the next morning he did so from jail.

After leaving our offices he had decided to visit the Lunar Libation Point, one of the rougher bars within a long day's crawl. There had later been a slight difference of opinion with management and clients concerning the swallowing of live goldfish, during which Knox had lost his swagbag and all his identification papers.

Thirty days, without the option. However, Knox had, with that unconscious forethought which commands so many of our actions, chosen to give the sentencing judge an assumed name. He said that he was Waldo Burmeister.

So Norbert was easy. He was ready to sign on at once. It was Waldo who proved awkward.

''I'd never pass as him!''

''The people we'll be meeting have met him, but they don't know him well. They'll have no reason *not* to think you're him.''

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"He's *ugly*."

"We can make you look ugly."

"I have no idea how that Converter works."

"Knox will teach you. He says there're certain built-in safeguards, but once you know those you'll have no problem."

"He's a lot thinner than me."

"You can lose weight."

Waldo glanced at me with a certain sly satisfaction. "I'd have to lose thirty pounds. You'd have to help me do it."

The unkindest cut of all. Waldo's price for agreeing to the impersonation of Norbert Knox was that I *help* him to win a bet—a bet with me.

I reluctantly agreed. Over the next week Waldo began to grow his hair and a loathsome moustache, and was fitted with brown contact lenses. He visited Norbert Knox in jail regularly for learning sessions about the Knox Converter, which soon began to appear far more complex to operate than I had expected.

The one real weakness was Waldo's voice. He sounded nothing like Norbert Knox. We agreed that he would speak very little, and then in a lower voice. After listening to the series of sub-human grunts that he produced, I suggested that so far as possible he should not speak at all.

As the days went on I also noticed with supremely mixed feelings that despite my admonitions to diet, Waldo did not appear to be losing an ounce. The day we shipped for Hyperion he was as fat as he had ever been.

Well, he could tell anyone who asked that the food on Earth and Moon had really pleased him, so that he had put on a lot of weight. From Knox's descriptions of Hyperion cuisine, that was wholly plausible.

I might still win my bet, and my case. For there was no doubt that, weight aside, Waldo was coming to bear an uncanny resemblance to Knox. On the long trip out to the moons of Saturn, he even started to talk about "*my* Converter" and "*my* rights being violated."

"Waldo," I said, "it's not *your*—"

"Who's this *Waldo* person? I'm Norbert. Remember?"

He was right. He had to adopt the Knox persona as far as humanly possible. I bit my tongue and said nothing. But I decided that Waldo had been right about one thing. Norbert Knox *was* ugly.

If there is one prime rule of legal practice, it is this: *No surprises*. Whatever your client may have done, no matter how unspeakable and ghastly, it is better to know about it, and decide in advance how you will respond to it when your learned colleagues bring it up in court.

In Norbert Knox's case, full disclosure was even more important than usual. Waldo needed to know the good, the bad, and the ugly, because he was going to *be* Norbert Knox. We told Norbert, as we tell all our clients over and over, "Don't hold anything back. Don't even *think* of holding anything back."

It never works, of course. There is always something. We learned what it was in Norbert's case within minutes of docking on Hyperion.

We had passed through customs to the entry point of the Deep Vault and were waiting in an antechamber for our

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first meeting with Knox's employer, when a woman rushed into the room.

"Norbie!" she squealed. She grabbed Waldo, held him at arm's length, and cried, "Oooh, you've put on some weight. I love it! It looks really good on you. How long before your meeting is over?"

"Er—arr—grrm."

"It starts in just a few minutes," I said.

It was designed to discourage her. It did no such thing.

"We'll be back in a few minutes, then. Come on, you sweet man!" And she dragged Waldo away, out of the room. I started to follow, and was halted in my tracks by a glare that would have stopped the Juggernaut.

I was left behind, to think dark thoughts. It was no surprise that Matilda Sykes—I learned her name later—would find Norbie's increased girth appealing. She herself was what is sometimes referred to as a "big woman," who bounced more than she walked and would have benefited, I felt, from a good flensing.

But there had been a dreadful tone of intimacy in her voice. Surely she would be back at any moment, to denounce "Norbie" as an impostor.

I was worried, too, about Waldo. He is not what one might term a ladies' man.

Nothing wrong with that, mind you. I am not one myself. But I do feel that hard experience has made me rather more adroit in avoiding the larger pitfalls of interaction with the fair sex.

That opinion was confirmed a few minutes later, when Waldo hurried back into the room.

"She's his *girlfriend!*" he croaked. "He never told us about her. She expects me to *sleep* with her tonight! Henry, what am I going to say? What am I going to *do?*"

I could not offer an answer. I certainly could not tell Waldo what I was really thinking, which was that I was rather pleased at Matilda's reaction. After all, if Waldo was accepted as Norbert Knox by her, after who-knew-what level of personal contact, surely he would be acceptable to anyone on Hyperion.

Fortunately I did not have to offer advice to Waldo, for at that moment the door to the main chamber opened, and we were ushered in to meet the arbitrator and the opposition.

I had some hope that the whole business might be easy and swift. The arbitrator was Judge Hugo Melmoth, a neutral party from the neighboring Saturn moon of Dione, and he made it clear during our introductions that he was eager to return there as soon as possible.

We had already disposed of certain preliminaries remotely, by communication between the Moon and Hyperion. I had received a copy of Norbert Knox's employment contract, and it seemed clear enough. Inventions related to his work belonged to the company. Inventions unrelated to his work, and made on his own time, remained his. One could assume that a food synthesizer had little or nothing to do with hard-rock mining. The only question was whether Norbert thought of it and built it on his own time or the company's. And given his flat statement that he had done it all at night, the burden of proof was on them.

But the company's negotiator, Dorita

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Treece, stated their position in the first five minutes of the meeting.

"Read the contract, Mr. Carver," she said. She was a wiry redhead, who had not given the dejected "Norbert Knox" more than a moment's glance. I could have appeared with a rubber dummy for all she cared. "It's quite specific. I'll quote you the relevant part. 'Paragraph 6.A: Such work-related inventions include all processes for mining of rocks, for minerals extraction, and for the refurbishing of used materials for repeat use.' Now, the Synthesizer"—she carefully avoided calling it the Knox Converter—"is nothing more than a device for 'the refurbishing of used materials for repeat use.' As such, it is unquestionably a work-related invention, and the company owns it."

She was right. Undeniably right, unquestionably right. Fortunately such considerations have little or nothing to do with legal decisions. Otherwise Waldo and I would have been out of business long ago.

"Judge Melmoth," I said, "I would like to enter into the record *Poindexter vs. Boshem, Europan High Court Ruling, 103.44*. That ruling makes it clear that the wrongful association of unlike entities is not permitted. And while this employment contract refers to rocks and minerals, it does not by any stretch refer to *foods*, which surely makes that a wrongful association."

"The Courts of Hyperion, Mr. Carver," interjected Dorita Treece, "do not provide for the general acceptance of Europan High Court rulings."

"Now, Ms. Treece," said Judge Melmoth. "That's *my* line. Don't demonstrate to everyone that I am unnecessary. I would hate to be added to the ranks of the unemployed!"

Dorita Treece laughed. I laughed. Even Waldo laughed, from force of long habit.

Did I say that the first rule of legal practice was, no surprises? I am sorry. That is the second rule. The first rule is this: When the judge makes a joke, *everybody* laughs.

"Your Honor," I said, "you and Ms. Treece are absolutely right, in that the Courts of Hyperion do not provide for the *general* acceptance of Europan High Court rulings. But they do not exclude *specific* acceptances, where relevant to a case."

"Point noted, Mr. Carver," said Judge Melmoth. "Proceed."

And away we went. It's nice to work with a professional, and Dorita Treece was one. My only regret was that we were working on a contingency rather than an hourly charge basis.

At the end of the first meeting I was quite pleased with our progress. We had not yet fought anything more than first skirmishes, but we had mapped out the battlefield.

Norbert/Waldo was far less contented. "Matilda said she'd be waiting for me when we got through," he said. "She's there now, Henry, outside the door. I can see her."

The door was just ajar, and there was certainly a Matilda-like form sounding and surfacing across the field of view. I turned my attention to that problem.

"It's no disaster if she insists that you have dinner with her, you know."

"Dinner! It's not just dinner. If you'd heard the things that she proposes to do to me, and have me do to her; your flesh

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would crawl."

"Norbert—"

"I'm not Norbert. I'm *Waldo*. I wish I'd never heard of Norbert."

"Waldo, listen to me. This is no time for panic."

"Not for you, maybe."

"Nor for you. Look, we won't be here more than a week or two. You go and have dinner with Matilda tonight. And you explain to her that while you were on Earth you allowed yourself to be led astray. You caught something—nothing serious—that makes you unavailable for dalliance, much though you wish it were otherwise, for a couple of weeks."

He stared at me, a pathetic wish to believe in his eyes. "You really think it would work?"

"Trust me."

"The hell with dinner, then. I'm going to do it right now! Wait here." He hurried away through the door, before I could question his judgment on the timing and setting of his confession.

It didn't take long. In less than five minutes he was back. One eye was already swelling, and he was limping. All thought of dinner or anything else with Matilda, now or at any time, had apparently been banished.

And wouldn't you know it, he didn't even thank me.

I sometimes say unkind things about Waldo, but to put the record straight I have also to admit that on occasion he goes to the heart of a problem in a way that borders on genius.

Take the Norbert Knox contract, for example. Dorita Treece had a strong case, twist and turn the facts as I might. It was Waldo, pondering the idiosyncracies of Hyperion law after a quiet dinner with just the two of us, who achieved the key insight. He had been browsing through a list of statutes when he paused and looked across the table at me.

"You know the old saw about 'Possession being nine-tenths of the law'? Well, did you know that it is stronger here on Hyperion than anywhere else in the system, and more literally true? Look at the record."

He was right, but I read it without much interest. I was not feeling my best. On the journey out I had picked up what promised to be a snorter of a head cold, and already my brain felt woolly.

"Very good," I said. "But we don't *have* the Knox Converter. The company has it."

"At the moment they do. But I know where it is, down in the Deep Vault. If I went there and took it . . ."

"With the case involving it unresolved, and now before the arbitrator? We'd lose our license—not just here, right through the system."

"I don't *have* a license. Remember? I'm not a lawyer, I'm simple Norbert Knox, hard-rock miner. Suppose that I were to take an action without even mentioning it to my counsel?"

I thought, for maybe ten seconds. Then I leaned forward, my hand cupped to my ear.

"Mr. Knox," I said, "if you want me to help you, you will really have to learn to speak up. I haven't been able to make out one word you've said for the past five minutes."

As I explained later to Dorita Treece

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and Judge Hugo Melmoth, there was no possible reason why a lawyer should *not* accompany his own client on an innocent sight-seeing tour of the Deep Vault.

Norbert Knox was a familiar figure there, received with waves and calls of "Hi, Norbie." No one sought to block his path or restrict his access as we approached the chamber that housed the Knox Converter.

That struck me as a little odd. The company knew Hyperion law far better than we did. Surely its staff would have worried that Knox might try to steal the invention?

I realized why they were not in the least concerned when we at last slid back the outer seal of the chamber, proceeded through a massive inner door, and had our first view of the Knox Converter.

Norbert Knox claimed to have told Waldo everything there was to know about his invention. Everything, that is, except the *size*. We were gazing at a mammoth structure that extended from one end of the chamber to the other. Its pipes and ducts resembled a jungle of spaghetti cooked up by a mad master chef, and its folded upper section soared close to the domed chamber ceiling. The possibility of moving it even a fraction of an inch, let alone stealing it, was zero.

I was ready to leave, then and there. But Waldo was not. He had spent days discussing this thing with Norbert Knox, and his curiosity was roused. He went down the steps into the chamber and stood by the machine.

"I had no idea it would be so *big*," he said. "But here's the intake." He walked to a vast open tank at one end, now empty, with a monster pipe that led from it out of the left side of the chamber.

"And here's the first stage processed product," went on Waldo. He walked across and patted another huge hopper in the middle of the chamber, this one full to the brim with a grainy white material. He picked up a fist-sized chunk and sniffed it. "Just as Norbert said. This will need final processing and flavoring in the third stage there, but it's perfectly edible." He took a thoughtful nibble. "Not bad at all."

"Waldo, I don't care if it tastes like the Food of the Gods. We're wasting time here. It would take an army of people and equipment to move this thing." I started back up the steps to leave the chamber. "Let's go, and do something useful."

"Not yet. See, this is the control panel." Waldo had found a mess of buttons and toggles and keyboards low down in front. There must have been a couple of thousand separate switches, not one of them labeled. "It's quite a tricky operation, but this is what you would do to turn it on."

He started fiddling with an array of keys.

"Waldo! Not now. Come on, before anyone starts to wonder what we're doing here."

He nodded, but he came with me only as far as the inner door. He stared at that thoughtfully. It was massively solid, like so many Deep Vault fixtures, and it could be locked from both sides.

"You know," he said, "as I read Hyperion law it would be better for us to—"

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"Hey there!" Three men had arrived unannounced at the outer door of the chamber. "Excuse me," said their leader, "but we've got instructions not to let anyone get too close to that machine. So if you would move right out of the chamber, now—"

I began to comply. But Waldo didn't. He gave a shout of defiance, stepped back into the inner chamber, and began to slide the door closed.

"Waldo! Norbert!" I cried.

"I'm staying," he called to me just before the last crack closed. "Possession is nine-tenths of the law! You tell them that. And tell them that I'll stay here as long as I have to."

"But food—"

"I'll run the Converter. I'll make all that I—"

His last words were cut off as the door clamped to its hermetic seal. The security staff came running past me, but they were too late. All they could do was bang uselessly on solid steel. Waldo was beyond reach.

Dorita Treece could suspect me of anything, and she did. But she could not prove that I had encouraged Waldo's actions, or even known of them in advance. In fact, the security staff all made statements that suggested I was as startled as they were by what had happened.

Waldo added to that impression. He would not talk to me any more than he would talk to her. His only comment, shouted through the impregnable door, was that he would come out when they agreed that the Converter belonged to Norbert Knox, and to no one else. Then there was the gigantic swishing roar of the Converter being turned on, and further conversation became difficult.

It was a real stalemate. My meetings with Dorita Treece continued, but I think we both sensed that we were just going through the motions. For as long as Norbert Knox stayed in the Deep Vault, Hyperion law said that the Converter was his. On the other hand, what happened as soon as he came out?

My own feelings at that point inclined to pessimism. Waldo was stubborn—no one knew that better than I—but while he was locked in the chamber, life in the rest of the Vault could continue as usual. Hugo Melmoth had already shipped back to Dione, and would not return until Waldo emerged. Dorita Treece must know she had the stronger hand. She would simply out-wait us.

I thought some about Waldo, and what he was going through. But by the second day I began to think much more about myself. My cold had turned into a real killer, and the inside of my head felt three sizes too big for my skull case. My sinuses were on fire. Worse than that, while Waldo sat fat and probably happy, pigging out as never before on high-quality Converter products, Matilda Sykes without Norbert in her life had chosen to set her sexual sights elsewhere.

She pursued *me*. At every break I saw her too-friendly face beaming in from the outer chamber, and she was waiting for me at the end of the business day. Back home on the Moon, escape would have been easy. Here there was nowhere to go. The Vault of Hyperion formed one tightly-connected ecosystem, and Matilda could find me with no trouble at all.

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"I've learned my lesson," she said, on the evening of the fourth day after Waldo's voluntary immurement. She had invited herself to my table at the restaurant, only a few seconds after I sat down to a quiet dinner. Thanks to my cold, the food was already like ashes in my mouth. Matilda's next words made it taste worse.

"Norbie has what it takes to give a girl a good sweaty time," she said, "but he's not a *gentleman*. I never learned anything refined from *him*. But you, now, you're another matter. If a girl spent some time close to you, she could *learn*. She could *improve* herself."

Her comments had to end there, because I had gulped a big lump of bread down my windpipe and she was too busy slapping me on the back and loosening my collar to do any more talking. But even in my anguish I sensed that she was not discouraged.

The next night she sought me out again. I would have hidden away in the crowd, except that the whole Vault seemed to be busy with some odd form of emergency and we were practically the only people in the restaurant. There was also no food, but with Matilda coming on strong that was the least of my worries.

"I was trying to say it last night," she said, leaning forward to show about half an acre of what would have been better left covered. "I wanted to tell you that any girl who spent a night or two snuggled up close to you could really learn something. Mind you." She giggled, and reached under the table to squeeze my knee. "Mind you, learning might not be a one-way street. I think I could teach you a few things that you'd find real interesting."

Her fingers started to walk their way up my thigh. I pushed my chair backwards, before her groping hand could reach to extremes. She giggled again and said, "Oops! Sorry."

But she wasn't, not in the least. I knew this was no more than a temporary reprieve. There was a remorseless single-minded drive to Matilda, a strength of purpose enough to batter down all normal human resistance. Waldo had felt it, and panicked. Now I knew why. And the argument about a temporary indisposition due to a former liaison would not work twice.

Legal cases are decided in strange ways. I decided that as long as I stayed in the Vault of Hyperion I could not escape Matilda. *Ergo* . . .

On the morning of the seventh day Dorita Treece and I were not scheduled to meet. For the past three days, she had actually seemed to be avoiding me. But now I went to seek her out.

"Dorita," I said as I stepped into her apartment. "If you'd be willing to talk—"

I wanted to say that I was ready to give up. We would agree that Norbert Knox had no claim at all to the Converter. But I was interrupted by the overwhelming need to sneeze, and by the time that I emerged from my handkerchief she had slammed the door and turned to me. Her face was pale and furious.

"All right," she said. "I know why you're here, Carver. You don't need to gloat. You win. I'm having the papers prepared for signature, and Norbert Knox will get all rights to that damned

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Converter. There's only two conditions: One, *make him switch it off*. Then two, we want it—and him, and you for that matter—away from Hyperion, as soon as possible."

As the prophet Ecclesiastes so aptly remarks, there is a time to keep silence, and a time to speak. Uncomprehending as I was, I sensed that this was the former. I allowed Dorita Treece, still seething with anger, to lead me towards the chamber that held the Knox Converter.

Halfway there, she halted at a supply room. "We'll need helmets."

"Why?"

She stared at me, and now rage was mixed with amazement. "What do you mean, why? Don't you smell it?"

I sniffed, as much as my blocked sinuses would permit. "Perhaps a slight odor of melons?"

She shook her head. "It's up to you." She pulled a helmet over her own head, and started walking again. I noticed that while on my previous visit this part of the Vault had been full of people, now it was totally deserted.

We came to the massive inner door. Dorita Treece hammered on it with her fist.

"Norbert Knox!"

"What do you want?" It was Waldo, no doubt about it. But his voice was curiously thin and weak, with the roar of the Converter still in the background.

"This is Dorita Treece. We're ready to sign over the rights to the Synthesizer to you, as soon as you switch it off."

"I don't believe you."

"It's true. I have Mr. Carver with me. You can talk to him."

"I'm here," I said. "Let me in."

"I need proof that it's you. Give me some identification."

Identification, at a time like this?

"Waldo!"

"That will do." There was a sound of heavy latches clicking into different positions, and the great door slowly swung open. I hurried through, and on down the steps.

It was a mistake. I found myself standing up to my knees in a sloshy, viscous sea. Waldo was just a few feet away, but it was a Waldo transformed. He appeared frail and dwindled. Beyond him loomed the Knox Converter, thrumming and vibrating with insane energy.

There had been other changes. Whereas on my previous visit the middle hopper had been one giant mound of processed product, now it was almost empty. But the input pipe and tank was filled to overflowing and beyond.

Within the chamber, the noise was terrific. There was a certain other ambience that I did not care for, even with my cold-stuffed head. I stepped closer to Waldo. "You have to turn it off."

"What?"

"Turn it off." I was bellowing as loud as my sore throat would permit. "*You have to turn it off!*"

He glared at me, and his eyes seemed to pop from their sunken orbits. "What do you mean, *turn it off?* What do you think I've been trying to do for the past week?"

That's really the end of the story. Not so far as the inhabitants of the Deep Vault of Hyperion are concerned, of course. They say that it will take years to get rid of the smell. But a quick call

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to Norbert Knox in his Luna jail cell provided the control sequence that had eluded Waldo, and the Converter was switched off in minutes.

Even so, Knox was profoundly impressed by what Waldo had done. He said that it had never occurred to him that it was even *theoretically* possible to run the Converter *backwards*, from processed food to raw sewage. For Waldo to discover that mode so quickly, and then flood the interior of the Deep Vault with such noisome and intolerable results, showed genius of a high order.

I didn't tell Waldo what Knox said. He is insufferable enough as it is, and anyway what he did was the result of pure accident and incompetence. But within hours we had a signed agreement from Dorita Treece that the Converter would be shipped FOB Luna, as soon as a crew could be found willing to work inside the Converter chamber. At that point Waldo and I departed Hyperion in high spirits.

The Moon, when we reached it, had never looked so good. I swore I would never leave again. Everything seemed perfect. Norbert Knox owned the Converter, and he would soon be a multimillionaire. And Waldo and I were rich, too, because we had a piece of the action.

Of course, Waldo won his bet, and I would lose my most comfortable chair, because he had shed his fifteen pounds and more. I have discouraged any attempt on his part to describe in detail his days, closeted so to speak with the Knox Converter, but the atmosphere in the chamber apparently destroyed all interest in food, even for so dedicated a gormandizer as Waldo.

It was not that loss, however, that evaporated my sense of euphoria within twenty-four hours, and has Burmeister and Carver working night and day to secure Norbert Knox's early release from jail. And Norbert seems truly touched by the intensity of our efforts.

"You're really not charging me for any of this work?" he said.

I shook my head. "Not one penny. Here, sign this document quickly, so Waldo can hand-carry it over to the judge."

He paused, pen in hand. "I've heard of lawyers doing free work—*pro bono*, isn't that what you call it?—but I've never seen it."

"Happens all the time. Here, you sign it right there."

"And you really think you can have me out in less than three days?"

"*Sign, dammit.* I'm sorry, I mean, yes, that's what we're hoping."

Praying would have been a better word. ALL IS FORGIVEN. ARRIVING LUNA SOONEST, SEE YOU IN 72 HOURS. LOVE, MATILDA. That message was written in words of fire within my brain and Waldo's. She hadn't said who was the intended recipient, but neither Waldo nor I was willing to take the chance.

Norbert signed—at last. I rushed out of the cell and handed the document to Waldo. He hared off towards the courthouse, faster than a speeding bullet.

I took a look at my watch. Thirty hours left out of seventy-two. Thirty hours, to place the human shield of Norbert between us and Matilda.

It was going to be touch and go.

Who says that lawyers don't earn their money? ■

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THE ALTERNATE VIEW John G. Cramer

NUKE YOUR WAY TO THE STARS

This column describes the *nuclear salt water rocket*, a radical new concept for propulsion in space. It is the idea of Robert M. Zubrin of the Martin Marietta Corp., author of the fascinating, recent *Analog* science-fact article "The Magnetic Sail," which the cover described as "a liberating new concept in space travel." The nuclear salt water rocket is another such liberating concept.

The basic difficulty with space propulsion comes down to the problem of *energy*. There simply is not enough energy stored in NASA's best chemical fuels to generate much push. The laws of physics dictate that if the push (specific impulse) is low, the fuel consumed per second must be correspondingly very large to provide enough thrust (upward force) to boost a reasonable payload. The laws of economics dictate that a very large fuel consumption must be very, very expensive. And finally, the laws of politics dictate that any project that is very, very expensive will be dominated by political decisions rather than scientific and engineering decisions. Within these boundary conditions the politics-before-engineering-before-science proclivities of NASA and the current dismal state of the US Space Program are inevitable.

Zubrin proposes to break out of this dilemma by going nuclear. His is not the first such idea. Project Orion, a product of the swords-into-plowshares theme of the late 1950s, proposed to propel a space vehicle by using a series of nuclear bombs exploded behind a thick steel plate to drive the space vehicle forward. Orion was rendered illegal and canceled because of the Test Ban Treaty of 1963.

There have been more recent proposals for high-energy space propulsion systems. My alternate view column "Laser-Sustained Propulsion and the 4 P's" (*Analog*, Aug.'87) described an innovative high-energy launch system that would use a very high power (10 MW to 1 GW) ground-based laser to create a sequence of planar explosions behind the launch vehicle, vaporizing thin surface layers from a "fuel block" on the rear of the vehicle and driving the resulting gas cloud into a plasma explosion with a strong laser pulse. This concept is still under active development at the Lawrence Livermore Laboratory, but no suitable

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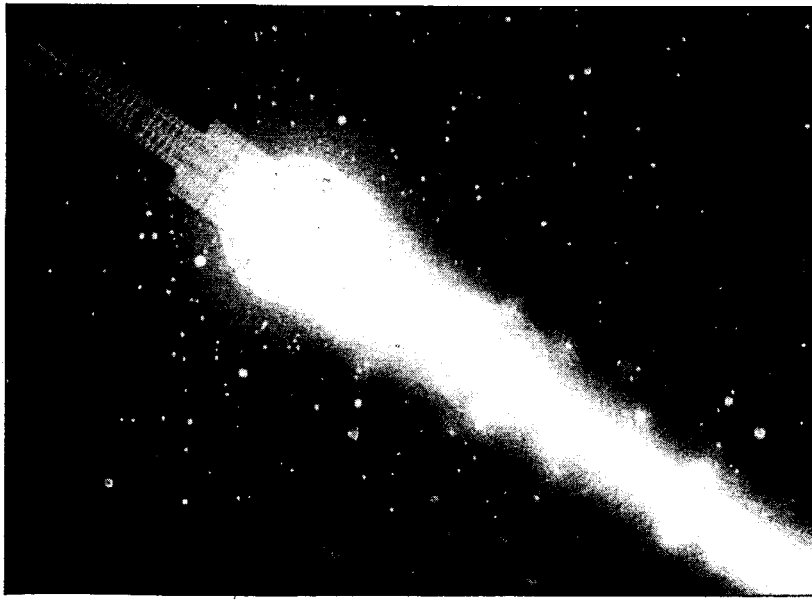
laser is presently available for a full-scale test of the concept. High energy propulsion systems that would use antimatter annihilation or pulsed thermonuclear fusion have also been proposed. However, both of these concepts require technologies that are at least two decades away from any practical full-scale implementation.

Zubrin's nuclear salt water rocket (NSWR), on the other hand, requires only minor extrapolations from the mature technology of existing nuclear power systems and could probably be implemented for prototype testing in a very short time. Writing the environmental impact statement for such tests, however, might present an interesting problem, because Zubrin's scheme vents highly radioactive nuclear fission products directly into space. It is therefore appropriate mainly for deep space missions. It is, in a sense, complementary to the laser-sustained propulsion scheme which requires a ground-based laser within shooting distance of the space vehicle.

In his paper describing the concept, Zubrin considers using NSWR for a round trip mission to Titan, Saturn's largest moon. The NSWR would be fueled by 20% enriched uranium in the chemical form of a soluble salt (uranium tetrabromide) dissolved in ordinary water at about the same atom number concentration as the salt in sea water.

Fissionable isotopes in such concentrations can easily produce great heat from fission reactions or even a nuclear explosion. An uninterrupted volume of this liquid massing a few



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dozen kilograms would reach critical size, massively fission in a sustained chain reaction, and explode. In Zubrin's scheme 41,000 kilograms (41 tonnes) of the salt water fuel are stored in a neutron-absorbing fuel tank. The fuel tank would be made from long tubes of boron carbonate, a strong structural material that strongly absorbs thermal neutrons, preventing the fission chain reaction that would otherwise occur in the fuel. The liquid fuel from the tank is pumped from the storage tank into an absorber-free cylindrical reaction chamber which allows buildup of neutron flux to the critical point where sustained nuclear fission can occur.

In a nuclear rocket the reaction chamber presents a severe materials problem because no conceivable mechanical structure could sustain the force of a nuclear explosion. However, Zubrin uses a very clever trick. He has used a simplified model to show that the distribution of fission-inducing thermal neutrons in the reaction chamber depends critically on the velocity of the liquid fuel as it passes through the reaction chamber. This dependence occurs because the moving salt water fuel is also the medium in which the neutrons are slowed. If the liquid is at rest, the maximum flux occurs at the center of the cylinder, but if the moderating fuel liquid is in motion, the point of maximum flux is skewed downstream and also rises to a much higher maximum. If the right fuel velocity is chosen, the thermal neutron flux (and therefore the site of maximum fission energy release) can be made to peak very sharply just outside the exit end of the cylindrical reaction chamber.

In other words, one can produce a continuous controlled nuclear explosion in the region just behind the nuclear rocket. At this point the water of the fuel liquid flashes to very high temperature steam, expelling reaction mass with an estimated exhaust velocity of 66,000 meters per second (as compared with perhaps 4,500 m/s for a chemical rocket). The NSWR engine is calculated to produce a thrust of almost 3 million pounds (1.3×10^7 N) and to have a power output of 427 gigawatts. With this kind of performance, the mission to Titan could be launched from low-Earth orbit with an acceleration of almost 4 g's and could, in principle, be carried out with low launch mass, low cost and high efficiency.

Zubrin also considers how a NSWR might be used in a more ambitious 120 year one-way probe mission to Alpha Centauri. He envisions a 300-tonne spacecraft carrying 2,700 tonnes of salt water fuel containing 90% enriched uranium. This highly enriched fuel would be burned in a high-efficiency engine to produce an exhaust velocity of 4,700,000 m/s, permitting the spacecraft to achieve a velocity that is 3.63% of the speed of light. He proposes to use most of the fuel for acceleration and to use a magnetic sail (see *Analog*, May '92) for deceleration by creating drag against the interstellar medium.

What Zubrin has described, therefore, is a high-energy space propulsion technology suitable for deep

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space and interstellar missions that could be implemented with fairly modest extensions of current technology. Moreover, the end of the cold war has left in its wake considerable stockpiles of fissionable materials (^{235}U and ^{239}Pu) from decommissioned nuclear weapons that can be regarded as a source of cheap fuel for such projects.

Zubrin also points out that, despite the highly radioactive exhaust of the NSWR, the engine itself need not be radioactive to any significant degree. The fuel has only low-level alpha activity, the fission products from the consumed fuel are vented into space, and the induced activity from the large neutron flux produced by the fission burning can be minimized by constructing the engine from such low activation materials as graphite and silicon carbide. Once the engine is turned off, therefore, there should be no significant radioactive inventory present to endanger the crew of a manned mission.

The highly radioactive exhaust, of course, constitutes a major disadvantage for the NSWR scheme. The prospect of contaminating space with radioative waste is certain to draw strong opposition from the same environmental and anti-nuclear groups that have opposed the use of nuclear power sources in NASA's deep space missions. Zubrin argues, however, that the NSWR's exhaust velocity of 66 km/sec far exceeds the escape velocity of any planet, and that as long as the exhaust vector does not intersect the Earth "the amount of contaminant reaching the Earth could be insignificant," even in an NSWR launch from low-Earth orbit. In fact, since the atoms of exhaust gas have sufficient velocity that they are not bound by the Sun's gravity well, the expelled exhaust will dissipate rapidly and will soon leave the Solar System altogether. Zubrin also points out that since the NSWR is not a weapon or a bomb, its testing and use does not violate the 1963 Test Ban Treaty. Therefore, unlike the Orion scheme, its use as a space propulsion system is legal.

There would, of course, be some very demanding technical challenges in designing a safe and reliable NSWR. The extremely high exhaust temperature and velocity of the device present a particular challenge in designing an exhaust nozzle for the NSWR that will not be severely eroded during a brief period. Zubrin suggests that a continuous flow of normal (unsalted) water along the surface of the reaction chamber and nozzle could provide cooling and extra reaction mass, but this remains to be demonstrated. A full design would also have to consider possible failure modes, including the possibility of a fuel pump failure that could cause a fuel detonation within rather than behind the reaction chamber. These appear to be solvable problems, but they would have to be addressed.

In summary, the NSWR appears to be a radical but feasible solution to the problem of mounting an interstellar mission with essentially existing technology. An unmanned Alpha Centauri probe of the type that Zu-

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brin suggests could be built starting today and at a cost that I would guess would be much smaller than the growing price tag of NASA's troubled Space Station Freedom project. The anticipated mission time of 120 years is a long time. But the sooner we start, the sooner we (or our descendants) will get a closeup look at our neighboring star systems. ■

Nuclear Salt Water Rocket:

R. Zubrin, "Nuclear Salt Water Rockets: High Thrust at 10,000 sec I_{SP}", *Journal of the British Interplanetary Society* 44, 371-376(1991);

Magnetic Sail:

R. M. Zubrin and D. G. Andrews, "Magnetic Sails and Interplanetary Travel," AIAA 89-2441, AIAA/ASME 25th Joint Propulsion Conference, Monterey, CA, July 10-12, 1989;

Robert M. Zubrin, "The Magnetic sail," *Analog*, May, 1992.

●Error is none the better for being common, nor truth the worse for having lain neglected.

John Locke

●We are still dreaming about the stars, but we seem too cautious to reach for local planets. The general passion for high-tech projects cannot continue if we do not actually carry some out.

John H. Mauldin (in *Prospects for Interstellar travel*)

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ARNOLD THE BLUE-NOSED CYBORG

William S. Davis

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Wherein old traditions are dragged kicking and screaming into the future. . . .

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"Ho, ho, ho my ass!" Santa pushed his chair back, jumped to his feet, and threw his clipboard against the wall. Then, hands on the table, he leaned toward his lawyer. "She can't have the bloody elves. Period!"

"Chill out, Claus," cautioned the lawyer. He paused to knock the ash from the end of his cigar and then brushed a speck from the lapel of his dark blue, pin-striped suit. "She's got you by the short hairs."

"Listen, Sacowitz," countered Santa, jabbing a finger at his counselor. "I pay you guys enough. Make her let go." He turned and pointed at his computer. "Or I'm going to check my list and delete all the bloody lawyers."

Sacowitz smiled. Over the years that threat had become an inside joke between them. Then his demeanor turned serious. "Santa, my old friend," he began, "the firm of Sacowitz, Vanzetti, and Rashad has represented you for many, many years. You're just going to have to trust us on this one. Give her what she wants. You can't afford to go to court."

"I can't afford to go to court?" Santa looked shocked. "*I* can't afford to go to court?" He gestured toward himself. "Hey! I'm Santa Claus, dammit! What jury is going to convict Santa Claus?"

"Look Claus. I'll be blunt." The lawyer leaned back in his chair, took a puff on his cigar, exhaled the smoke slowly, and then took a deep breath. "We've been fighting the toy companies for years," he continued. "They want royalties on your knock-offs. We almost lost that copyright infringement suit last year. Legally, they had us. The only thing that saved us was your image. You're right; no jury is going to vote against Santa Claus. But a messy divorce . . . " Sacowitz paused and shook his finger at Santa. "A messy divorce would be such a public relations disaster that all bets would be off. I'll say it again. You can't afford to let Mrs. Claus take you to court."

"Bull!" countered Santa. "Mrs. Claus doesn't deliver the bloody toys. I do."

Exasperated, Sacowitz rolled his eyes toward the ceiling. Then he turned back to Santa and shook his head. "I don't think you realize how bad this is," he said, finally. He gestured toward the public relations expert sitting across the table. "Fill him in, Jean."

"Don't give me any PR surveys," interrupted Santa. "You bloody so-called experts—".

"Shut up and listen, Claus," growled Sacowitz. He nodded. "Go ahead, Jean."

Jean Fernandez was a tiny, frail-looking young woman, but the look in her eyes commanded attention. She slid toward the front of her chair, paused briefly to adjust her yellow, pin dot cravat, and smoothed the lapel of her blue, pin-striped suit. "I don't know how to put this nicely, Santa," she began in a soft but clear voice. "But lately your public image has been slipping. Badly. In fact, 27.5 percent of the adults we surveyed think you are a dirty old man."

"That's ridiculous," snorted Santa. "Where in the world did you dream that up?"

"We can track the beginning of your slide to the night your infamous video premiered," replied Jean, as though

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Santa had not interrupted her.

"Hey. I'm a celebrity. She asked me. That was good PR."

"I beg to differ with you," countered Jean. "The sight of a fat old man wearing tight red leather pants and a 'Born to Raise Hell' T-shirt was definitely *not* good public relations."

"I liked the part where he helped that sexpot strap on her brass brassiere," added Sacowitz with a chuckle.

"I told you not to do that video, Santa," said Jean.

"OK. OK. Maybe I was wrong. But—"

"And that's not all," she continued. "That preacher in New Jersey didn't help, either."

"I thought we were suing that dingbat," snapped Santa.

"We don't have a prayer," replied the lawyer.

"What? The SOB called me Satan! That's libel."

"Not quite Claus. What he said is that Santa is an anagram for Satan. Technically, he's right—same five letters. You can't prosecute him."

"You lawyers amaze me."

"There's more, Claus," continued Sacowitz. "I met with your soon-to-be former wife's lawyers last week. If this divorce goes to trial, at least two female elves are prepared to testify that you sexually harassed them. Also, Mrs. Claus is prepared to identify a female elf named Candy as the 'other woman.' "

"Think of it," added Jean. "Santa has a thing for elves. The same guy who holds little kids on his lap and climbs down the chimney on Christmas Eve is a pervert with a thing for little people. I'm damn good at my job. But how do I counter that?"

"Let the elves go, Claus," warned Sacowitz.

"But—" started Santa.

The telephone rang before he could finish. He grabbed it. "I said no calls!" he snapped into the receiver, angrily. Then his expression turned grim. "Send him in," he ordered. "Damn!" He slammed down the telephone and turned back to his lawyer and his public relations consultant. "Problem with the reindeer," he explained. "Sorry for the interruption. This shouldn't take long."

The conference room door swung open and in bounced a rather strange looking, big-eared elf wearing green tights, red slippers, and a red T-shirt with the letters I.O.O.E. printed above a crest of arms. "Yo, Claus," he shouted in a voice like a rapper on helium. "Like the shirt, man?" He grabbed it with both hands and pulled it away from his body to show off the printing.

"International Order of Elves," said Santa to his lawyer. "Elf union. The little twerp loves to piss me off." He gestured toward the elf. "This is Bruce. He's my reindeer expert."

Skipping any further introductions, he started toward Bruce. "Now, what's going on with the reindeer?" he demanded as he walked across the room. His tone of voice suggested that the answer had better be good.

"They can't fly," replied Bruce.

Santa stopped just a few feet from the elf. He towered over the little fellow. "Why can't they fly?"

"Basically because they're these big bovine mammals with lead in their asses. Hee, hee, hee." Bruce looked at

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Jean, who couldn't help grinning. "Little elf humor. Hee, hee, hee."

"I'm about this close to ripping off your ears and stuffing them up your nose," growled Santa, holding his thumb and forefinger about an inch apart. "So cut the crap. Why can't the bloody reindeer fly?"

"Vertigo."

"Vertigo?"

"Yep. They're dizzy. Can't even stand up. And that's not all. You could change the first letter in Comet's name to a V, if you get my drift. Hee, hee, hee."

"How did they get vertigo?"

"Sinus infection. Too damn cold up here."

"What about the backup team?"

"Same problem. Something's going around. Figure at least a week before we have a healthy team."

"Christmas is in two days."

"Tell me something I don't know, Claus," grinned the elf. "Fortunately, I have an alternative."

"I'm almost afraid to ask," said Santa. "But tell me about it."

"Arnold."

"What the hell is Arnold?"

"A cyborg reindeer."

"A cyborg? What the hell is a cyborg?"

"A cybernetic organism. A robot. An artificial reindeer. Andrew invented it."

"I thought I fired that bloody little . . . "

"You can't. He has a grievance pending. Besides, this cyborg really works! You got to see it, Claus!"

"Guess I do," sighed Santa. "Give me five minutes; I'll meet you at the barn."

"Right on, Claus!" The elf saluted Sacowitz, bowed deeply to Jean, turned, and bounced out the door without saying another word.

"Why me?" pleaded Santa Claus, throwing up his hands in exasperation. "Why me? That's it; I'm retiring." He walked slowly back across the room and slumped in his chair.

"We'll continue our discussion later," said Sacowitz, getting up to leave. "Go take care of your problem."

"Right," agreed Santa in a soft voice. He slumped even deeper into his chair as his lawyer and his PR expert filed quietly from the room.

"Up, Dasher!" commanded Santa. Dutifully, the big reindeer struggled to his feet. "Come!" One hoof moved forward, tentatively. Then a stricken look darkened the animal's face. His legs wobbled. Then they splayed out away from his body, and his chest hit the floor with a sickening thud.

"See," said Bruce. "They can't even stand up. No way they're going to fly."

"Yeah," agreed Santa forlornly. "Show me the bloody cyborg."

"Yo, Andrew!" shouted Bruce. "He wants to see it."

"Oh boy, oh boy, oh boy!" Andrew's excitement preceded him into the room. Unlike most elves, he preferred laboratory whites, and his much too long lab coat streamed behind him as he bounced through the barn door. "Wait till you see it, Santa! You'll never use reindeer again. Automation is the wave of the future. Oh boy, oh boy, oh boy!"

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A few minutes later the two elves and the fat man were standing on a flat patch of packed snow inspecting Andrew's creation. Its shape resembled a reindeer. Sort of. Its stocky, angular body was supported by four stumpy legs and the surface was painted a metallic reindeer color. In place of antlers it had two antennas. And its nose glowed a dull blue.

"Meet Arnold," said Andrew, proudly. "Arnold the blue-nosed cyborg. Like him?"

Santa's expression suggested reservations. He circled the beast, examining it carefully. "Antennas?" he asked, finally.

"One's for radar. The other one is a microwave receiver. You can tap into the satellite navigation system. You'll never get lost."

"Legs look like stumps."

"They adjust automatically to compensate for the slope of the roof."

"Hmm." Santa continued his inspection. "Why isn't it rounded? I don't know if I like all those angles."

"Stealth technology. Remember two years ago when SAC almost shot you down? You won't have to worry about that any more. You'll be invisible to radar."

"Sounds good. Why the blue nose?"

"FAA regulations."

"If I'm invisible to radar, why do I have to worry about FAA regulations?"

"Good point." Andrew stroked his chin a few times, trying to think of an answer. Then he quickly changed the subject. "Just try it, Santa," he urged, shoving a control device into the fat man's hands. "You'll love it!"

Santa stared at the black, boxlike object. On its top, near the center, was a joy stick. To its left was a slide control marked altitude. To its right was another slide marked speed. Several buttons were arrayed along the top front edge, including one red one.

Andrew jabbed a finger at the joystick. "That controls your direction," he said. "Forward is north, left is west, and so on. The slide on the left controls your altitude; forward for up, toward you for down. The slide on the right controls your speed. You move it away from you to go faster."

Santa continued to stare at the controls, looking more and more confused by the second.

"Try it," suggested Andrew. "Press the button marked start."

Santa pressed the button. The cyborg started to hum. Then it seemed to come alive, hovering a fraction of an inch above the ground.

"Move the altitude slide away from you."

Santa moved the slide, and the cyborg rose smoothly, majestically into the sky.

"Now pick a direction." Santa hesitated, staring at the controls. "The joy stick. Move it toward you. That's south. We're at the north pole, so that's the only direction you can go."

Santa moved the joystick, but the cyborg didn't move. "Give it a little speed. The right slide." Santa moved the right slide forward, and the cyborg started moving smoothly toward the south. "That's enough speed," suggested Andrew. "Now move the joystick to the left." Santa moved the joystick, and Arnold the blue-nosed cyborg began to fly in a westward circle around

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the north pole. Santa grinned.

"Give it more speed!"

Santa moved the slide and the cyborg accelerated. He moved the slide again, and the cyborg went even faster. Soon it was little more than a brown blur circling overhead. Santa's grin widened; he was enjoying this.

"Try the other controls," prompted Andrew.

Santa did, and before long he had the cyborg flying high speed, three-dimensional figure eights. "Ho, ho, ho," he laughed, in his best jolly fat man form. Up, down, left, right, faster, slower! Loops, climbs, dives! Santa was like a kid with a new toy.

"What is this button for?" he asked, touching the red one.

"NOOOO!" screamed Andrew. Too late. Overhead they heard a muffled boom. Then there were two objects. The driver's seat, attached to a parachute, started its slow descent while the cyborg reindeer and its sled plummeted toward the earth like a dart. A split second later, it crumpled into a nearby snow bank.

Santa just stared, his mouth open. He dropped the controls.

"That was the eject button," said Alfred, calmly. "You shouldn't have pushed it."

Santa just stared, his mouth open.

"I think you broke it."

Santa continued to stare, his mouth open. But his ears were turning red.

"That was really dumb."

Santa moved with a suddenness that belied his girth. He grabbed Andrew by the neck, lifted him off the ground, and started choking him. "You bloody little twerp!" he shouted. "I could have been killed!" He shook the elf. Fire seemed to flash from his eyes.

"Help!" shouted Bruce. "Santa's harassing Andrew again. Help!"

In no time at all, a small army of elves surrounded Santa, beating his thighs with their little fists and shouting at him to stop. Meanwhile, Andrew turned blue and his eyes bulged.

"Let him go!" bellowed Sacowitz as he rushed to the scene.

Santa hesitated.

"We don't need *another* lawsuit, Claus."

Santa stared at Sacowitz. Then he slowly relaxed his grip. Andrew dropped to the ground and lay still.

The other elves gathered around, looking solemn. Andrew seemed dead. But suddenly he bounced to his feet. The elves cheered. He coughed a few times and rubbed his throat. Then, as if nothing had happened, he started talking. "Fortunately, I have a backup." His voice croaked a bit, but he seemed fine. "It's just a prototype, but it's programmed, so you won't have to worry about screwing up the controls. All you need is one button. Even you can handle that."

"Yeah, dummy," chimed in one of the elves. "Klutz!" squeaked another. "What's the matter, Santa? Ten thumbs?" "Time to retire, you old fart." Two of the elves lifted Andrew to their shoulders and started off toward the barn. The other elves followed, their high-pitched insults fading as they streamed away.

"Just insert the disk and push the start button," said Andrew. "The program does the rest. Think you can han-

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dle it? Hee, hee, hee."

Santa gave Andrew a dirty look, but he didn't have much choice. It was Christmas Eve, and Arnold the blue-nosed cyborg, release 2.0, was his only option. Canceling Christmas was out of the question. He'd suggested it, but Sacowitz just said, "100,000,000 breach of promise suits," and that was that. So Santa grabbed the CD, slipped the disk into the drive, and pressed the start button. The cyborg rose smoothly and started south.

The elves watched until Santa was just a dot in the sky. Then they filed back into the warmth of the barn.

A few minutes later, Andrew emerged from his lab, a disk in his hand and a worried look on his face. "Bruce!" he shouted. "We got trouble."

"What now?" demanded the reindeer expert as he reluctantly left his spot in front of the fireplace and started toward Andrew.

"I think I gave him the wrong disk. Boy is he going to be mad."

"What's wrong with the disk you gave him?"

"It's test data. It only lists towns that begin with the letter A. Boy is he going to be mad."

Madawaska, Maine was Santa's traditional first stop, but the cyborg landed at Allagash, a nearby town. "Different program," thought Santa. "Probably the most efficient route." He delivered the toys to the good little Allagash girls and boys, climbed back into his sled, and hit the start button.

Next came Abbot Village. Then Albion.

Something was wrong. "Bangor, you idiot! Stop at Bangor!" shouted Santa.

Alfred. Andover. Addison. Arlington.

"Boston, dammit!"

Amherst. Ashley Falls. Avon. Albany. Amityville.

"Oh, bloody hell! That's New York City down there!"

Asbury Park. Atlantic City. Allentown.

"Stop! That's Philadelphia!"

Altoona. Akron. Athens. Annapolis.

"Not Washington. Please don't skip Washington. Please not Washington."

Alexandria. Appomattox.

"Oh bloody hell!"

Asheboro. Abbeville. Albany. Atlanta. Apalachicola. Anderson. Aberdeen. Atwood. Alexandria.

"You're dead Andrew! You bloody elf."

Attica. Altamont. Ann Arbor. Appleton. Arlington. Auxvasse. Arkadelphia. Archibald. Austin. Abilene. Amarillo.

"Andrew's going to die. Andrew's going to die."

Apache. Arapahoe. Ames. Academy. Alamo. Antelope. Albin. Atwood.

"Santa Fe. Please! I love Sante Fe."

Albuquerque. Ajo. American Fork. Amargosa Valley. Anaheim.

"Forget the Los. It's a trivial prefix. Stop at Angeles. Please, stop at Angeles!"

Azusa. Apple Valley. American Falls. Astoria. Agate Beach. Anchorage.

"You're going to die, you bloody elf!"

Andrew heard the bellowing even before the cyborg landed. Santa was lum-

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bering toward him just as soon as the sled touched the ground. Like a potential victim trying to ward off Count Dracula, Andrew stretched a compact disk toward the advancing fat man. "You took the wrong disk, dummy," he said in a shaky voice.

Perhaps he should not have said that.

"The good news is that Mrs. Claus decided to settle for the condo and the money," said Sacowitz from his conference room chair. "Guess she figured there wouldn't be much left if she waited. The bad news is that we're talking damage control, Claus."

"What exactly are you trying to tell me?" asked Santa.

"You're in big trouble."

"Blame Andrew. It was his fault."

"Unfortunately, you killed him," interjected Jean, sarcastically. "That gives him the sympathy vote."

"We can deal with that," said Sacowitz. "Justifiable elficide. Don't worry about it."

"Killing elves isn't exactly consistent with Santa's image," she growled. "I can still see the headline." She pantomimed pointing to each word. "SANTA STRANGLES ELF! Beautiful."

"Build a new image," suggested Sacowitz. "Passion mixed with kindness. You're the expert."

"Well," replied Jean, thoughtfully. "He is due for a make over. And times have changed." She flipped open her notebook and made a few quick notes. "Let me think about it. It worked for Clint Eastwood."

"Might not make any difference, anyway," whined Santa. "How big is that class action suit?"

"Last count . . . " Sacowitz flipped quickly through his own notebook. "Ninety-two million, ah . . . Call it ninety-two million." He looked at Santa. "But they're all breach of promise, and it's up to them to prove a promise was made. You haven't written anything in over fifty years, so that won't be easy. At the very least, we can hit the department stores, the television networks, and the Salvation Army with at least some of the blame. They made the implicit promises. Not you."

"You can probably get the software supplier, too," suggested Jean.

"Right," agreed Sacowitz. "There's precedent there. Comstock versus VaporWare. Seems a rounding error in a spread sheet cost Ms. Comstock a contract, so she sued for a few million and won. Anyway, we can claim a software error caused the foul-up. Even if it didn't, people like to blame computers."

"So you think I'll be back in business by next Christmas?"

"Should be. Might still be a few cases pending, but the appeals could drag out for years."

"By the way, Santa, how are the reindeer doing?" asked Jean.

"Sold them to Burger Biggie," replied Santa. "I needed the cash."

"How the hell am I going to explain that?" Jean cringed. "You sold the reindeer for hamburger? You have to tell me these things, Santa!"

"Sorry. I forgot."

"How do you plan to deliver the goodies next year?" asked Sacowitz.

"Cyborg."

"After what happened this year?"

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"Sure. You can't fight progress. I hired a couple of people from Toonland Studios to fix the software, so that won't be a problem. Besides, it was great to spend Christmas Eve without the reindeer stench."

"I can hear the song already," said Jean. "Arnold the blue-nosed cyborg," she sang, softly. ■

IN TIMES TO COME

● Next month marks this magazine's 63rd anniversary, and our January double issue celebrates with a suitably dazzling array of fiction and fact. Stephen L. Burns leads off with "Leap," a gripping novelette of a man with a couple of big problems he must solve alone—almost—after a hair-raising accident in space. Vincent Di Fate supplies the dramatic cover.

Harry Turtledove has a long novella, "Down in the Bottomlands," about an alternate Earth in which the Mediterranean Sea, so central to the development of our civilization, did not refill after the last time it dried up. Spider Robinson and several of the Callahan regulars are back with "The Immediate Family," introducing a worthy successor to a venerable institution and a man with a lot on his mind. We'll also have two wildly different novelettes by Charles Sheffield and L. Sprague de Camp, and a goodly assortment of shorter stories. The fact article, by Duncan Lunan and Gordon Dick, treats a subject that should interest most science fiction readers: flight in nonterrestrial atmospheres—or, as the authors subtitle it, "The Hang-Glider's Guide to the Galaxy."

Finally, I remind you that it's time again to vote in the Analytical Laboratory (ballot elsewhere in this issue), and the January issue will contain the complete Index to 1992 to make that task easier. Remember, your voting helps us bring you the magazine you want—but in case you need an extra nudge, we've added one this year: every ballot will be entered in a drawing for a free one-year subscription.

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Probability Zero

HOMEWORK

Don D'Ammassa

If only Victoria hadn't been so determined to impress her new science teacher, the problem might never have arisen.

She was feeling guilty about her happiness when she arrived home from school the day following Mr. Shelley's assumption of the biology class from Mrs. Polidori, whose ill health had finally forced her retirement. Victoria really didn't have anything major against Mrs. Polidori, but Mr. Shelley was an absolute dream.

"How was your day, dear?" Her mother called her usual greeting while Victoria struggled to fend off the affectionate attention of the family dog, an oversized mongrel named Percy.

"It was OK, Mom. We've got a new science teacher."

"That's nice." This was her mother's invariable reply, punctuation rather than communication.

"We're all supposed to paint our bodies and go to school naked Friday."

"That's nice. Make sure you do your homework right off."

Victoria nodded to herself, having confirmed that her mother was not, in fact, listening at all. But she remained in a good mood, even found a nice chewy for Percy before running upstairs to her room to work on this term's science project.

They'd been studying protozoa, and because this was Victoria's special interest, she'd been light-years ahead of the other students and had found Mrs. Polidori's ponderous lectures boring and filled with minor factual errors. Percy followed her upstairs, but she determinedly closed the door so that he could not enter her private world of microscopes, chemicals, infrared lamps, and other, more arcane, instruments. The new nuclear accelerator her father had bought for her fourteenth birthday loomed large in one corner.

Without a second thought, she picked up the detailed cell diagrams she'd been

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working on and tossed them into the recycling field. Mrs. Polidori had taught physics last term, and Victoria still smarted from the woman's reaction to her functioning cold fusion generator. A "B minus" indeed!

For Mr. Shelley, however, something special was required. Victoria's brow furrowed as she quickly ran through a series of options, then uncreased as she made a decision. It was a good idea, but it would take time. She'd have to start right away to meet the Friday deadline.

The week passed quickly, but by Thursday Victoria knew that her experiment was not only successful, but had actually exceeded her original plan. Mr. Shelley would certainly be impressed.

Inside its glass tank, a genetically tailored amoeba had grown to a diameter of nearly half a meter, which was almost twice what she had expected. And judging by the spectroscopic analysis, the media was largely depleted of its nutritional content. She hastily corrected the situation, lest her experiment die prematurely.

In the morning, her father readily agreed to drive Victoria and her project to school. Once again, the nutrients had been leached from the solution, but she felt confident the creature would survive long enough to be graded.

At school, she borrowed a cart from the janitor and wheeled her project to the lab room, plugged its power cable into the wall, and hurried to home room. It was going to be a wonderful day.

It turned out otherwise.

Victoria arrived home that evening distracted and drained of enthusiasm.

"How was your day, dear?" Her mother seemed not to have moved from the couch for several days.

"Terrible. Disastrous. Horrible. Catastrophic. Worse than you could possibly imagine."

"That's nice."

Victoria dropped her books on the hall table and trudged up to her room, not reacting when Percy bounced along at her heels. She didn't even close the door, but lay full length on the bed, and ignored Percy's energetic attempt to encourage petting. He was persistent, however, and she finally relented, scratching him gently behind the ears.

"Percy, you don't know how awful a day it's been. And I don't even have anyone to talk to about it."

Percy turned his head, ears alert, tongue hanging out of one side of his mouth.

"I know, Percy. You'd help me if you could. But you're just an animal. You wouldn't understand." Her shoulders rose and fell as she sighed dramatically, then turned to stare at the far wall.

"There's just no way to explain to your dog how the homework ate the teacher." ■

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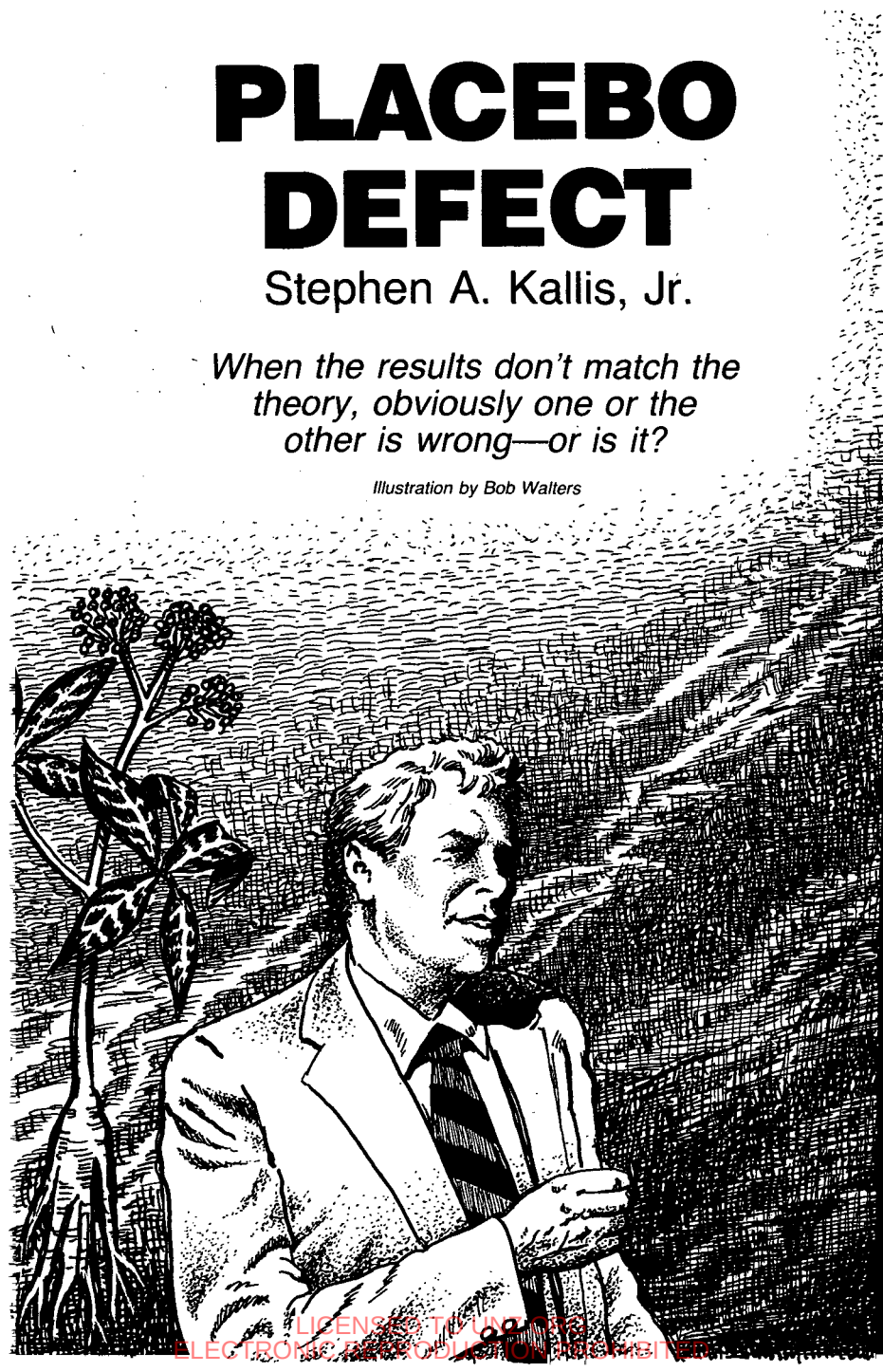
PLACEBO DEFECT

Stephen A. Kallis, Jr.

When the results don't match the theory, obviously one or the other is wrong—or is it?

Illustration by Bob Walters



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All heads turned to look as Hollis Turner entered the small conference room. He moved to the chair next to the workstation and sat.

Katherine Sanchez regarded him. "So why the hurried conference?"

Turner made a low noise. "That'll become all too evident." He glanced around, nodded, and switched on the workstation and its slave projection unit.

It took a few seconds for the screens to light up and the system to boot up. Turner sat clam silent and stone faced as it did.

"I've got preliminary results back on phase alpha of Project Somerset," he said. "We used a sample population of 300. As usual, we conducted a double-blind test, with half getting the active medicine, and the other half getting a placebo."

As he spoke, he worked his keyboard, mouse, and cursor.

"Here are the results."

Most eyes turned to the large projection screen. There was a simple bar graph, with three bars. The first, which was in outline only, was labeled "100"; the second, which reached about half the height of the first, was labeled "A"; while the remaining bar, labeled "B," reaching about two-thirds the height of the first bar.

"Well? What do you think?"

Katherine cleared her throat. "From what I see here, it looks like the Somerset formulation is fairly effective." After a slight hesitation, she added, "Though the placebo seems abnormally high."

There were a couple of murmurs, in apparent agreement.

Turner snorted. "Statistically, I can't argue that Somerset seems to work. But tell me, Dr. Sanchez, what do you think of the placebo's result?"

"I said I thought it was high. In a case like this, oh, figure at the outside, maybe 20 percent. But nearly half . . ."

Turner nodded. "You think A is the placebo? A represents Somerset!"

Katherine glanced back at the graph, then again at Turner. "But that's . . . absurd. You're saying that a *placebo* is about 10 percent more effective than the active sample?"

"I'm not saying it. The medical charts of the subjects are saying it." He scowled. "I want to find out why."

On that unhappy note, the meeting ended.

Melissa Khan picked up the container, and regarded the pills within it. "Is this from the lot?"

Katherine nodded. "How many will you need to run a complete series?"

"Are they all the same?"

"As far as we know."

Melissa opened the container and shook out one pill. "This ought to be enough, if there's any active agent. Just to be safe, I'll take a couple more."

"How do you plan to do the analysis?"

"Initial separation to fractions through TLC, then infrared, magnetic resonance, and mass spec on each. The usual."

"How long?"

Melissa stared at the capsule as if she were reading something written on it. "Well, if we knew just what it was we were looking for, I guess . . . maybe a

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week or so. But, with this . . ."

"Turner's really hot on this."

"I know; I was there. I'll see if I can get a team on it. We can work in parallel. But we have only so many computerized instruments."

Katherine nodded. "Best I can expect. But I'll need periodic updates."

It was a short walk to the animal research area. Even before she got there, she could hear occasional noises from the larger animals, and the rattle of stainless steel bowls and bars.

Katherine pushed open the door and was assailed by a faint odor of what she called "zoo." While it was a combination of diverse animal scents, it had an overtone of an unnatural, institutional atmosphere. While not repugnant, it was a bit unpleasant, and she wished momentarily that she'd been visiting the research library, instead: old Schyler van Horst, the head librarian, had a private plant collection that invigorated and sweetened the air there instead of slightly fouling it, as in the lab.

However, the zoo smell was more to her than a condition of the air. It brought her thoughts momentarily back to when she first got into her line of work, and realized it was not that many years ago. She'd risen fast.

She nearly ran into Brent le Boeuf, who was armed with a clipboard and was wearing his lab smock. Katherine had heard that he always carried it with him: it had a blank of paper so he could take down notes at a moment's notice.

"Hi, Kath. What brings you this way?"

She smiled fleetingly. "I know it's been a while, but that's research biz."

Le Boeuf echoed her smile, and amplified it. "Ah, never a social call." He gave an exaggerated sigh, but there was a twinkle in his carbon-black eyes. "So why venture to the land of rats and hamsters?"

"Have you heard of the Somerset project?"

"Is the Pope Catholic? I don't know any of the details, but it's the latest of the bigger ones, no?"

Katherine nodded. "It could open up a whole new area of regeneration. This is connected."

"How? We did the preliminaries already."

"Something's come up and we'd like you to check it out."

"What?"

Katherine's thoughts raced. If she told le Boeuf she wanted him to investigate a placebo, he might miss something important. So, after a moment she said, "These were used in the test, but we got an anomalously high rate of recovery, given the initial projections. We'd like to have you test this batch on a sample of animals, just to determine whether it was a fluke." She handed him the container, which held a goodly supply of the tablets.

Le Boeuf glanced at the container briefly, and stowed it in a pocket. "It'll take time. What do you want? Primates, dogs, or mice?"

Katherine decided speed was important. "Mice'll do fine."

Le Boeuf fished for a pencil and jotted a few things down. "OK. I'll start today."

Back in her office, Katherine mulled over what she knew, which was very little. She'd read the project records,

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which showed no more deviation than any equivalent research. The tests on human volunteers was as perfect a double-blind test as she could imagine.

She sat in thought. The Placebo Effect was well known, but little understood. That a number of people could be given an inert pill instead of a drug and have their healing process accelerate over what would have taken place without "medication" had been established as a medical fact, but the mechanism remained elusive. *Why* people improved was still an open question. The suggestion that taking a placebo would increase the body's endorphin output, thus making the subject feel better so that the natural healing process would be more effective, was still skirting the issue. It was a nice rationalization, but it still didn't explain why feeling better might knit bones faster, decrease fever, and the like. It was a pigeonhole within a pigeonhole: it gave no less nor greater understanding of what was really going on than it would by saying the operative mechanism was elves.

Katherine pulled open a desk drawer and removed a small pill box. Opening it, she regarded one of the pills. It was a standard gelcap, opaque, with purple coloration. She'd watched when Melissa opened one, and the contents were a fine powder with a tannish color. It could have been anything from malt to dyed chalk. Whatever else though, the pill seemed highly potent, since it did better than the medication. That ruled out its being a placebo.

"Well," she said softly, "there's more than one way to feed a cat." She reached for the telephone.

* * *

As she walked through the doors, Katherine reflected that she hadn't dealt with security for years. She was met by Britt Sayers, who made sure that the walk towards his office took her past the newly computer-augmented monitoring equipment.

"We're pretty proud of our center here, Dr. Sanchez," Sayers said, gesturing at the mosaic of video monitors being watched by several security personnel. "I'm as aware as anyone of the costs this sort of installation incurs, but, considering the sensitive nature of pharmaceutical research, not to mention the substances the researchers come into contact with daily, I think you'll have to agree that it's money well spent."

Katherine laughed softly. "I'm not on the budget committee, Mr. Sayers. I'm not concerned about the cost, only the effectiveness."

Sayers stopped. "What do you mean?"

"Don't get defensive." She smiled. "Something a bit unusual happened with one of our projects, and I want to make certain I've covered all the bases."

"You mean sabotage?"

"I don't know you could call it that."

"Then what?"

"I'm curious about how easy it would be for someone to do . . . well, unsanctioned research."

"I don't follow you."

"I'll explain when we have some privacy."

In Sayers's office, Katherine covered the salient points, closing with, "As I see it, this either was a tremendous coincidence or someone decided to cook up his or her own cure privately, and

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without approval, and substituted it for the placebo. The gelcaps use one of our standard capsule blanks, color-coded purple."

She dug in her purse, pulled out the pillbox, and handed him one.

"Don't bother with any lab analysis; that's already in the works."

Sayers glanced at the pill in his hand, then at her. "Criminological lab analysis?"

"If you think you can find fingerprints on it, be my guest. Only maybe a dozen people have probably already handled it. The capsule is one of ours, so trying to trace it won't do much good. We're running a test on the contents, and I'll make sure you get a copy of the results."

Sayers ran his fingers through his thinning hair. "I don't understand. Just what do you want me to do?"

"Well, for starters, tell me how easy would it be to smuggle chemicals into the facility?"

"A lot easier than trying to smuggle 'em out. We're well aware of how easy it might be to make some 'designer' substance for . . . well, let's say for a good street value. So we have a pretty solid setup to detect . . . unusual chemical substances leaving the premises. But coming in is another matter. While the exit detectors might pick up some stuff, they can't be attuned to everything.

"But why bother? The capsules came from here, and there are plenty of raw materials in the complex."

Katherine thought for a second. "That's a possibility, but I want to cover everything I can think of. Do you think it'd be worthwhile looking for an unauthorized project?"

"It would take a little time . . . but yes."

Nodding in satisfaction, Katherine said, "Good. That takes care of the inside. But as to smuggling the stuff in from outside. . . ."

Sayers smiled crookedly. "Depends on what that 'something' is. You ought to be aware of how very tiny some chemical dosages can be and still be highly effective. LSD is the classic example of that. Now if, say, a capsule this size full of the pure stuff could be diluted against all the placebo tablets, then it'd be a matter of a very small and easily concealable carrier. Not likely we'd spot it, unless the smuggler was very careless and it had some distinctive feature, like an extremely strong, unusual, and noticeable odor."

"And if it had to be larger?"

Sayers pulled open a desk drawer, and extracted a small package, which he handed to her. "You can get prophylactics at any drug store these days. If the sample was in the form of a powder, you could pack it in a double layer of these. I'm certain you can think of a place or two where you could stash it while you carried it in. It's one dodge that's been used in narcotic smuggling for as long as I can remember. And that's just one example. Something could come inside somebody's lunch bag, or briefcase, for that matter, if disguised innocently enough. Come to think of it, I'll bet a reasonable number of the people here have prescription drugs that come in capsules."

He laughed. "We're prepared to try to stop people from taking things out of here; that's all. It's like Harry Houdini

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said, long before I was born; nobody's on guard to prevent people from breaking *into* jail."

Katherine mulled that over. "What about explosives?"

"That's getting a bit far afield, but we do have detectors for that. But I doubt your placebo medicine falls into that category."

"Right. So back to my question: could you determine whether any one's doing a bit of private research?"

Sayers frowned. "I won't say 'no.' But it won't be easy, just because of the nature of what you folks do here. Even with our monitors, detectors, and the like, you're the experts at what you're up to. This is a research facility, and on the basis of actions observed from a distance, it'd be hard for us to tell whether one of you folk was concocting a new medicine, developing a modified ointment, or brewing coffee. And I'm sure you don't want my people to stare over the shoulders of the researchers, confiscate lab books, and the like.

Katherine had kept the investigation on a low profile. She could imagine what the impact of a high-profile security investigation would do and shivered momentarily. "You're right there."

"I'll see what I can do," Sayers said cautiously. "I can't promise too much, though."

"Thanks. Do what you can."

On her way back to her office, Katherine made a detour to the research library. She logged onto the library's computer terminal, and tried some file searches to see whether she could locate journal papers of equivalent anomalies. However, after a couple of hours of search and scan, she came up effectively empty.

She consoled herself with the fact that at least for her, the air was a treat. Not like the animal lab, at all.

Almost three weeks to the day, Melissa Khan brought in the first report. The diminutive researcher entered Katherine's office still wearing her lab smock. She had a slash folder with her.

"You've got something?"

Melissa made a face. "I've got *something*. Just what it is . . . well, you might want to judge for yourself."

She walked over to the desk, pulled up a chair, and sat. She extracted printouts from the folder, and spread the top one on the desktop.

"There's a whole bunch of complex organics in what I've found. Some starches, a mucilage, camphorous aromatics, and some saponin glycosides. There are tiny traces of other aromatics, too."

"And?"

"And that's as far as we've gotten. No active chemical jumps off the page and says, 'I'm a healing agent!' I wish one did."

"Any conclusions?" Katherine paused and laid a hand on Melissa's wrist. "I know that's unfair. Better: any hunches?"

After a pause, Melissa said, "It's early in the game, but I bet we don't *find* a healing agent. What's here might have some odor, in large enough concentrations, but nothing seems that active. I'll bet you get more activity from a strong cup of tea."

A few days later, the animal lab reports came in. There was no significant

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difference in healing between the animals treated with the sample and a placebo made from scratch in the laboratory.

Katherine entered Hollis Turner's office with photocopies of the preliminary results in a slash folder. She handed them to him without a word and sat while he perused them.

After a few minutes, he looked up. "Very interesting, Dr. Sanchez. Is this all you've got?"

Katherine stifled an urge to snap at him. "So far. Although these data are inconclusive, I thought you'd want to be kept up to date."

Turner nodded absently, but with a slight frown. "Yes. At least it shows me a lot of effort is going into this. But it *is* inconclusive."

"Well . . . yes." Katherine realized one of the reasons she managed to rise as fast as she did was because she was able to keep cool. "The situation, though, is far from ordinary. The anomaly, if it isn't just a statistical quirk, isn't something that 'just happened.' Whatever's really going on has to be well planned and executed."

Turner smiled ever so slightly, and tucked the papers back into the slash folder. "Please don't assume that just because I'm holding down an administrative slot I parked my brains at the door, Dr. Sanchez. I realize that if this anomaly indicates some sort of new type of healing agent, it isn't going to be like penicillin. Nor could a healing agent of this type just 'happen' to find itself accidentally mixed into a placebo stock. If there's something to this, there has to be something thoroughly thought out involved.

"The problem is that there's an anomaly within the anomaly. The . . . agent seems to work on people, but it has no effect on mice. And that's hard to fathom. What in the hash of chemicals here could be that selective?" He tapped the analytical lab's report.

"It doesn't make sense, does it?"

Turner stroked his chin. "Maybe it's something too specific for mice."

"We have enough placebos left to try on a primate," Katherine said thoughtfully. "But not enough to do a good statistical sample."

"It's worth a shot. But I'm going to hate the delay."

"Me too. But unless someone comes up with a better idea, I can't see what else we can do."

Turner just nodded absently.

A couple of days later, Katherine found herself practically gridlocked in a supermarket checkout line. Although she didn't realize it, it was fortunate for her that she found herself where she was.

Her lack of progress on finding a solution had kept her working irregular hours, and her shopping had been seldom and erratic. As she was leaving the lab, she'd recalled there were a few things she really needed.

She'd swung by her usual grocery store to pick up the items on her way home. She'd wheeled her lightly loaded shopping cart to the "express" checkout line to discover that there was a long line at each active register, and slow going at all of them. At first, she entertained thoughts of just abandoning her cart, but decided that it would be less

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bother to endure the delay than to have to do it over later.

As she waited, she glanced around. One thing that couldn't help but catch her eye was the large number of tabloid newspapers on display by the checkout counter. The lurid headlines frequently amused her, and the current crop was no exception. Stories suggesting scandals of the rich and famous contended with tales of the strange and unusual. Mysterious disappearances vied with mysterious monsters and reports of extraterrestrials for the reader's attention.

However, one caught Katherine's interest. A small headline on one of the lesser tabloids declared, "Miracle Cures in Your Kitchen! Common Household Items Hold Key to Health!"

Giving a mental shrug, she picked up a copy to kill some time, and thumbed through to the article. *Makes as much sense as anything we've come up with.*

The article was a short piece about various folk-remedy herbal cures. She read that cabbage leaf could be used for bruises; that fennel seed could speed the metabolism to help one lose weight; that garlic could be used to lower cholesterol, act as an external antiseptic, and as a vermifuge; that papaya could be used as a digestive aid; and that thyme could be used to suppress coughs. The article concluded with, "There are dozens of low-cost items in the average kitchen that according to the ancient lore of herbalists, can help in the treatment of ailments. Since modern medicine has virtually ignored herbal treatments, who knows what miracle cures doctors might be overlooking, and which might be growing at our very feet?"

Katherine's initial reaction was a snort of amusement. She wondered momentarily where the writer thought all the antibiotics came from—a petrochemical plant? Penicillin was discovered by Fleming from a bread mold. Modern medicine owed a lot to plants, and if one looked at it the right way, the activity with mold research could be considered a refined form of herbalism.

She mulled over such thoughts for a minute or so, and that in turn led her to other associations. She vaguely recalled from her studies that medicine developed rather haphazardly: Western medicine stagnated in medieval times until people like Paracelsus started relying on practical cures over classical writings. The early pioneers tried anything that seemed to work, be it herbal or based on metal salts. In particular, as she recalled, Paracelsus went around gathering up folk remedies, which his colleagues sneered at. And if she recalled correctly, his cure rate was significantly better.

Katherine was placing the last of her items on the checkout conveyor when the thought struck her: *imagine the supposed placebo was actually an obscure folk remedy.* That might explain the anomaly. Suppose, just suppose, that someone had an old family remedy, or had read of something special. Making a mixture of herbal ingredients would be easy—and grinding dried herbs would be simplicity itself. It just might be worth looking into.

The following morning, Katherine went to the company library. She asked one of the librarians, Estelle Khouri, whether there were any books on file on herbalism of folk medicine.

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"I don't know of any offhand, Dr. Sanchez. Mr. van Horst knows something about herbs—I'm watering his collection while he's on vacation—but he won't be back for another week."

"I'd rather not wait that long."

"Just a minute." The librarian turned to a computer terminal and punched a few keys.

After a pause of less than a minute, a half-dozen titles came up. Katherine waited while the books were retrieved.

They turned out to be an odd lot. One was written by a doctor who believed that simple items like honey and seaweed could be used to effect a variety of cures. Another was a gardening book on how to grow various herbs, indoors or out. A coffee-table book described various herbs and had fairly striking photographs of some of them. One paperback book was a list of folk superstitions regarding ailments from around the world. A thin hardcover book extolled the virtues of garlic as a curative. And the last was a strange book of "arts and remedies" that a publisher's foreword indicated was first published in the mid-19th century.

This last book, *Long Lost Friend*, listed a number of cures for strange-sounding ailments such as "mother fits" and "horse sweeny." A lot of the entries were simple prayers or actions that sounded very much like magic spells, but here and there something medicinal-sounding popped up. "White vitriol" and "sugar of lead" dissolved in rosemary oil were supposed to be combined to make an eyewash. Sores on horses could be cured, according to the author, by a paste composed of white lily bulbs boiled in cream, or "Southern-wort" prepared the same way. Tree moss boiled in red wine could be used as a dysentery cure, the author claimed. Some of the herbal remedies were used straight; others, with adjunctive prayers or spells.

Katherine put the book aside with a sigh. Folk remedies at that level had too high a chaff content to find much wheat. At that, she reflected, there was only so much one would expect to find in a company library.

The municipal library proved more fruitful. She discovered more than a dozen promising titles, including *Rodale's*, *Lust's*, and *Spoerke's* guidebook. Katherine spent some time poking through the pages, and was struck by the mixture of practical and nonsensical information she found. Using baking soda or other bases to treat mosquito bites, for instance, made some sense as the venom was acidic; but curing warts by applying castor oil to them using a stolen dishrag, as an example, seemed downright foolish. There seemed to be a lot of superstition mixed into folk remedies—though that shouldn't be too surprising, she decided.

Even so, there was a lot of useful stuff buried in the remedies. She'd read that an old folk remedy of putting spiderweb silk on a cut was once considered sheerest superstition; yet later research indicated the clean spider silk reacted with platelets to increase the clotting factor. She had a hunch that what was going on at the lab was connected somehow to a folk or straight herbal remedy.

Katherine checked out the most technical of the herbal books and returned to the lab.

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* * *

A couple of days later, Katherine thumbed through Melissa Khan's latest lab report, and noticed the sketches of some molecules that had been derived from the various spectral analyses. After regarding them for a second, she pulled over one of the books she'd borrowed, and thumbed through the descriptions of active factors derived from the herbs. On the basis of the written reports, she thought she might be onto something. There were four saponin glycosides found in the placebo, and they seemed to fit the description of those associated with the ginseng plant.

Further checks revealed that other fractions were consistent with ginseng. Consistent with *Panax quinquefolium*, the "true" plant, as opposed to *Eleutherococcus senticosus*, which some references considered an equivalent.

Katherine had read enough about ginseng in the herbal books she'd borrowed to be both intrigued and dismayed. The reason was simple: ginseng was traditionally a cure for nearly everything, from blood disorders through male impotence. But people had been using ginseng as a curative for literally hundreds of years without showing any clear-cut evidence that it performed as advertised. One would think that anything that good would have shown *some* noncontroversial results.

Several of the books did say it was an "adaptogen," making it easier for other medicines to effect a cure. However, in this case, there didn't appear to be any other medicine, which led her right back to her basic dilemma: there didn't appear to be anything to substantiate the efficacy of ginseng as a cure on its own.

On the other hand, there was the anomaly with the Somerset data. The main distinction between what the subjects had taken and the standard laboratory placebo was the presence of ginseng. That couldn't be coincidence. But there was no clear-cut mechanism to explain what could be happening.

Katherine sighed. An engineer's definition of hell, she was once told, was a place where all the components functioned perfectly, but where the design wouldn't work. She was beginning to feel that her private version of the nether regions was where the components didn't work, but the medicine did anyway.

The following day, she collared Melissa Khan on break and suggested coffee. As they were relaxing over their cups, Katherine said, "By any chance, do you know anything about herbalism?"

Melissa shook her head. "If you mean about traditional Oriental herbal treatments—such knowledge doesn't come with the name," she said with a slight smile. "What were you looking for?"

"Something on ginseng."

"I've read it's prized throughout most of Eurasia. Maybe Sky van Horst could help."

Katherine smiled. "He's on vacation. He will be back in another week, but I hate to wait."

"You could try some health-food stores, I suppose. . . ."

"Not the best source, but I suppose I can give it a try unless something better comes to mind." Katherine wasn't

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thrilled with the idea, but reminded herself that what started her on her current tack was an item in one of the obscurer supermarket tabloids, read only by chance.

After the coffee break, Katherine had another thought. She headed back to the company's library. This time, though, she wasn't interested in books. She decided to check van Horst's collection of herbs, just to see what was there.

The fifth item she checked was labeled *Panax schinseng*. That was the Asian variety, which, according to what she read, had virtually identical properties, including chemistry, to *P. quinquefolium*. But it was interesting that he had the traditional plant. She decided that van Horst probably knew a great deal about herbalism, and began to suspect that he'd had something to do with the placebo switch.

Katherine took Melissa's advice, and visited a health-food store. She wasn't in the market for books of "borderline medicine"—if she could avoid them. But she did buy several small bottles of ginseng tablets: the manufacturers listed the botanical names, so she knew she had both the true herbs and those things called equivalents.

She had Melissa run the samples blind, and determined that the only active ingredient in the Somerset quasi-placebo pills was *P. schinseng*. And nothing else.

After scanning the report and its accompanying readouts for the dozenth time, in hopes of finding something she might have overlooked, Katherine reluctantly put it down. Technically, her job was "over," in the sense she'd found out "why" the placebo outperformed the Somerset drug—that is, because it was actually ginseng. She could pass the information along to Turner, and be done with it. But she didn't want to, and for two reasons. First, the least important, because it would present Turner with a problem that would have him turning the lab upside down trying to resolve it, while sending him the message that she couldn't handle the difficult stuff. Second, and critical, because she wanted to find the mechanism's explanation herself, for herself.

As to the solution, she'd become convinced the key lay with Schyler van Horst. She checked the calendar and noted that he'd return in five days, including the weekend. Even if she didn't catch him immediately, she certainly ought to be able to before his first day back.

Katherine figured that if Turner quizzed her before she'd had a chance to speak to the library head, she could stall him. The primate results weren't complete yet, after all.

She bought herself some additional time by meeting with Britt Sayers to see what security had come up with. As she'd suspected, they'd found nothing suggestive, much less conclusive, as to how the placebo could have been switched.

It wasn't until close to half-past ten the following Monday that Katherine was able to meet with Schyler van Horst. He was seated behind his desk when she entered his small office, but he rose to greet her.

"Dr. Sanchez. What a pleasure." Although van Horst was white-haired, with matching bushy white eyebrows,

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and had a face creased with wrinkles, he stood straight when he got up, and the grip of his leathery hand was firm and steady.

"Welcome back," Katherine said, trying to decide how best to question him. "Did you enjoy your vacation?"

"Yes, thank you. I went to visit some distant family members in York County."

"Where's that?"

"Rural Pennsylvania. Very lovely country, you know. I believe you'd enjoy seeing it."

Pennsylvania seemed to ring a bell, but Katherine couldn't put her finger on just how. "I might at that."

"Please, do sit. These old bones appreciate the comfort of a chair."

"Thanks."

With a smile, the old man regarded her from across his desk. "And what brings you to see me this fine day?"

"I've developed something of an interest in herbs," Katherine said cautiously. "I've seen the ones you grow and thought you might be able to give me some pointers."

Van Horst continued to smile. "I've no doubt I can indeed provide some information. Are you interested in cultivating herbs?"

Katherine shook her head. "I'm more interested in them pharmacologically."

"Oh? That I find interesting. Did you know that every herb I grow here has had some reputation as a healing agent at one time or another?"

"Kind of keeping with the nature of our work here, wouldn't you say?" She flashed a smile. "Sort of adds a traditional flavor."

Even as she spoke the words, "traditional" managed to establish the connection she'd been groping for. Katherine remembered the book with all the near-Medieval remedies, *Long Lost Friend*. She recalled from the preface that the author was from Pennsylvania. Maybe the relatives the librarian had been visiting were all herbalists. Compared to some of the "cures" in the book, ginseng was very conservative. Of course, the book was written in the early 1800s.

The old man leaned back and looked thoughtful. "There are many kinds of tradition, Dr. Sanchez. Some are rather beneficial; others seem to me to be far from it. I'm no physician, to be sure, but I have been around many years indeed, and I read a lot and I remember the majority of it. I've read of beneficial traditions; however, in medicine, some traditions are less than helpful. I cannot doubt you've heard of Paracelsus, and perhaps even the fact that he flouted traditional medicine to the point of burning the Canon of Avicenna in a St. John's Day bonfire. But were you aware that while the official cause of his death was that he was killed in a barroom brawl, there's some indication that he was really beaten to death by thugs hired by his jealous contemporaries?"

Katherine shook her head. "I never read that."

"Of course not. It's one of those things incidental to the story of medicine. But I would say it points up an example of the unhealthy side of tradition, if you see what I mean. Prior to Paracelsus, much of medicine followed a certain tradition; afterwards, it established new ones. But it seems the duty,

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in some quarters, for the new to throw out as much of the old as it can."

"Like . . . herbalism?"

Van Horst nodded. "Oh, some herbs have been recognized as worthwhile—foxglove is an example of that, I suppose. But at least in some quarters, I've noticed a tendency to see what herbal remedies can be replaced with 'safer' products."

Katherine considered that an oversimplification, but reflected that van Horst was not a pharmacological researcher; and a librarian, no matter how dedicated, couldn't keep current with all that was going on. She could barely do so herself.

She decided not to argue the point, since it seemed to be leading somewhere promising. "That could be. That's why I wondered whether you might be able to help me find some of the most reliable information on herbalism. We might be missing some good bets."

The old man smiled. "Come, Dr. Sanchez. I'm a bit weary, and I do believe that enough game playing is enough. I don't believe for a minute that you've suddenly developed an intense interest in herbalism. One so intense that you feel it necessary to hunt me up the very first morning I've returned.

"So what is your real interest, Dr. Sanchez?"

Katherine's thoughts raced. From the time she'd been hired, Schyler van Horst had been a gentle, friendly sort. Even his last question showed no hostility. And yet, it was hard to tell these days. The man was close to retirement—actually past the usual age—and tampering with an experiment was an extremely serious infraction of company rules. If she laid all her cards on the table, he might clam up—even try to cover any traces of what he'd done. And that would be a double loss: in addition to not being able to make a positive identification of the culprit, she might miss out on an interesting new area of research by failing to understand what mechanism was actually in play. So maybe she should play *some* of her cards.

"We're not sure how, but an herbal dosage somehow got mixed in with our placebo stock," she began carefully.

Van Horst nodded. "And it must have had some effect, or you wouldn't be here looking for answers, I'd wager. That is good."

"Good?"

"I have said I am too old to enjoy playing games, Dr. Sanchez, and so I am. So I do not play games with you: I believe that you're talking of *Panax schinseng*, and I should know, since I grew the plants myself. Surely, you do not believe that the samples I have here are all the plants I grow?"

Katherine looked wide-eyed at van Horst. "You admit you were responsible for the replacement?"

"Yes. Things cannot be too bad, or you would not have visited me alone, I would think. So how did things work out?"

She marveled at his calmness, and wondered whether that might be a function of age. He seemed as unconcerned about being caught as if he'd been discussing the weather.

"There . . . there was a statistical anomaly over what we'd have expected for a placebo."

"My, what a fancy way to say you

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got results," van Horst said with a chuckle. "Positive results, I hope?"

Katherine nodded. "Significantly so."

"There shouldn't have been any side effects with *Panax*. How did it compare with the experimental medication?"

Katherine paused, then said, "First, tell me something. I've actually been reading up on herbs somewhat. We identified the active ingredient as ginseng." She stopped.

"That is good. But when you indicated an interest in herbalism, I had figured you'd gotten at least that far."

"But in all my readings on the herb, the only ones that seemed to have scientific credibility indicated that the only property that ginseng has is as an amplifier, I guess, for the actions of other drugs."

The librarian smiled. "That is my understanding, too. From the time I was young, I spent a lot of time picking up the lore of some of my Pennsylvania relations, and from that became interested in herbalism. And from all my experience, and stripping away all the superstitions associated with a plant with a root structure that's shaped like a human, the best I have been able to determine is that the ginseng does indeed act as no more than an amplifier to whatever other healing mechanism is in operation."

Katherine felt dizzy. "But that's . . . we analyzed the pills and determined that ginseng was the only active ingredient."

"That is so," said van Horst.

By dint of personality, Katherine kept herself from screaming. "If that's the case, *just what on earth is the ginseng working with synergistically?*"

Van Horst raised his shaggy eyebrows in surprise. "Why, that should be obvious, Dr. Sanchez. It's amplifying the Placebo Effect." ■

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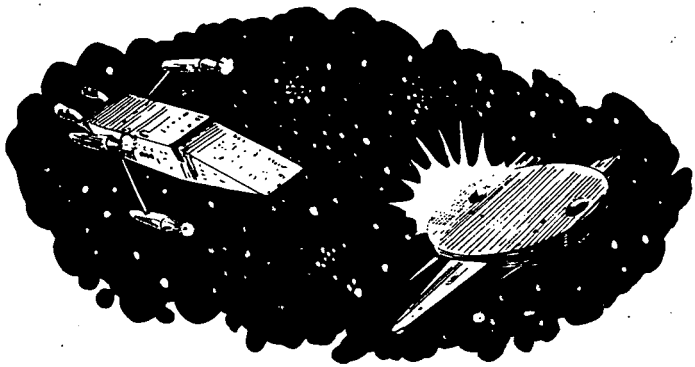
Probability Zero



PROTOCOL

Gregory R. Bennett

There were only three others in the president's office, but the small size of her audience did not alleviate Jeanette's anxiety. Admiral Aardmann had changed into his dress blues on the flight down, but the president and the senator from Texas were still in their bathrobes. At the admiral's urging, she lifted herself painfully from her chair, hoping the action would not disturb any of her bandages. She limped to the display screen mounted on the office wall and picked up an electronic stylus. Jeanette was pleasantly surprised that her shaking hand managed to keep the lines reasonably smooth as she sketched one of the aliens on the display screen.

"I see what you mean by them being low to the ground, Lieutenant Harrison," the president said. "But what does that have to do with the fact that you were the only crew member who

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was not killed when they boarded your ship?"

"I was lying down when they first saw me, sir," Jeanette Harrison explained.

She focused on the president. His confident demeanor, so effective on the video, was even more powerful in person. Deep inside, she wanted to believe this man could handle anything.

"When they came inboard, I was donning my suit," she continued. "The g-field was on, so I had to lie down to get my pants on."

"That's standard procedure," Admiral Aardmann added. "The airlock on the IS-11 scout is designed for donning the suit while lying on the deck. That way, the crew member doesn't have to support the weight of the suit."

Jeanette was comforted by the admiral's presence. His grandfatherly smile was the first vision she remembered seeing when they brought her out of somnolence in the infirmary at Hypatia Station. Jeanette had not realized who he was until she saw the seven stars on his collar. He had gently coaxed a report out of her and immediately set up this meeting in Honolulu so she could brief the president in person.

The president raised his eyebrows and nodded, indicating that she should continue.

"Symbolism and protocol are extremely important to the aliens, sir," Jeanette said. "They are violent, and very quick to anger. When they raise up on their hind legs and expose their underbelly, it's an expression of dominance. Those of superior rank use this body language to remind others of their place. Between those of similar rank, it's the worst of insults, inevitably leading to a fight."

"Looks like a stretched-out crab," the president mused.

"Yes sir," she agreed. "Or maybe a flattened armadillo. Except for a soft pink underbelly, their entire bodies are covered with smooth segmented armor, even the head and hands."

"You're sure they're coming here?" the president asked.

"Yes sir. When I escaped, their fleet followed me. Their ships aren't as fast as ours, but we have no match for their weapons. Not that I know of."

The president shot an inquiring glance at Admiral Aardmann.

"Lieutenant Harrison is correct, Jake," the admiral said to the president. "They fried that planet with more gamma radiation than we could deliver with every weapon in the fleet."

The president visibly swallowed and turned back to Jeanette. "I don't understand it," he said. "They wiped out an entire civilization! Why?"

"I never quite learned their language,

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sir," Jeanette answered. "There are a lot of subtle body movements I couldn't figure out. When I got them wrong, I got slugged. That's how I lost my left arm." Unconsciously, she used the stylus to point to where her left sleeve was pinned to her uniform tunic. "But from what I could tell, the other aliens were communicating with them on the wrong frequency. For some reason, they took that to be a most strident insult."

"So these guys are touchy, really touchy. And we've only got five weeks to get ready for them," he muttered. "We'll need you to help us catalog everything you can remember about their protocol, Lieutenant. I'll get a team working on that. But let's make sure I understand the high points. I assume you'd recommend I greet them in person?"

"Yes sir—" Jeanette started.

"And if I'm interpreting your meaning correctly, I ought to be groveling on my belly when I meet them?"

"You should be lying down, sir, but not groveling. It's the body language that counts. Your attitude should be very firm, almost arrogant. Act as befitting the most powerful leader of the human race, but stay down low. And you'd better have a suit made."

"A suit?"

"Space suit. Naked flesh is an offense. I was wearing a hard suit when they found me. I think that helped save my life."

Senator Whitmore interrupted. "You say they look like armadillos?" she asked in her carefully cultured drawl. "For God's sake, we'd better make sure there aren't any road kills around if they decide to visit Texas!"

"That was the sort of thing I was thinking about, ma'am," Jeanette replied. "Earth is loaded with symbols that might offend them. I don't think we need to worry about armadillos, though. They're the wrong size, and not really shaped like the aliens. Color and texture are far more important to them than shape. Under no circumstances should anyone insult an alien's armored carapace. They're more proud of their carapaces than anything else. And that's what scares me."

"Should we outlaw eating crabs while they're here? And protect beetles, too?" the president asked.

"Crabs and beetles don't really have the same appearance," Jeanette told him. "Wrong color, wrong texture. It might be a wise move, though, since I'm not sure. It's what I *am* sure of that is really terrifying."

"Well then, what do their beloved carapaces look like?" the senator exploded.

"White porcelain, ma'am," Jeanette replied. ■

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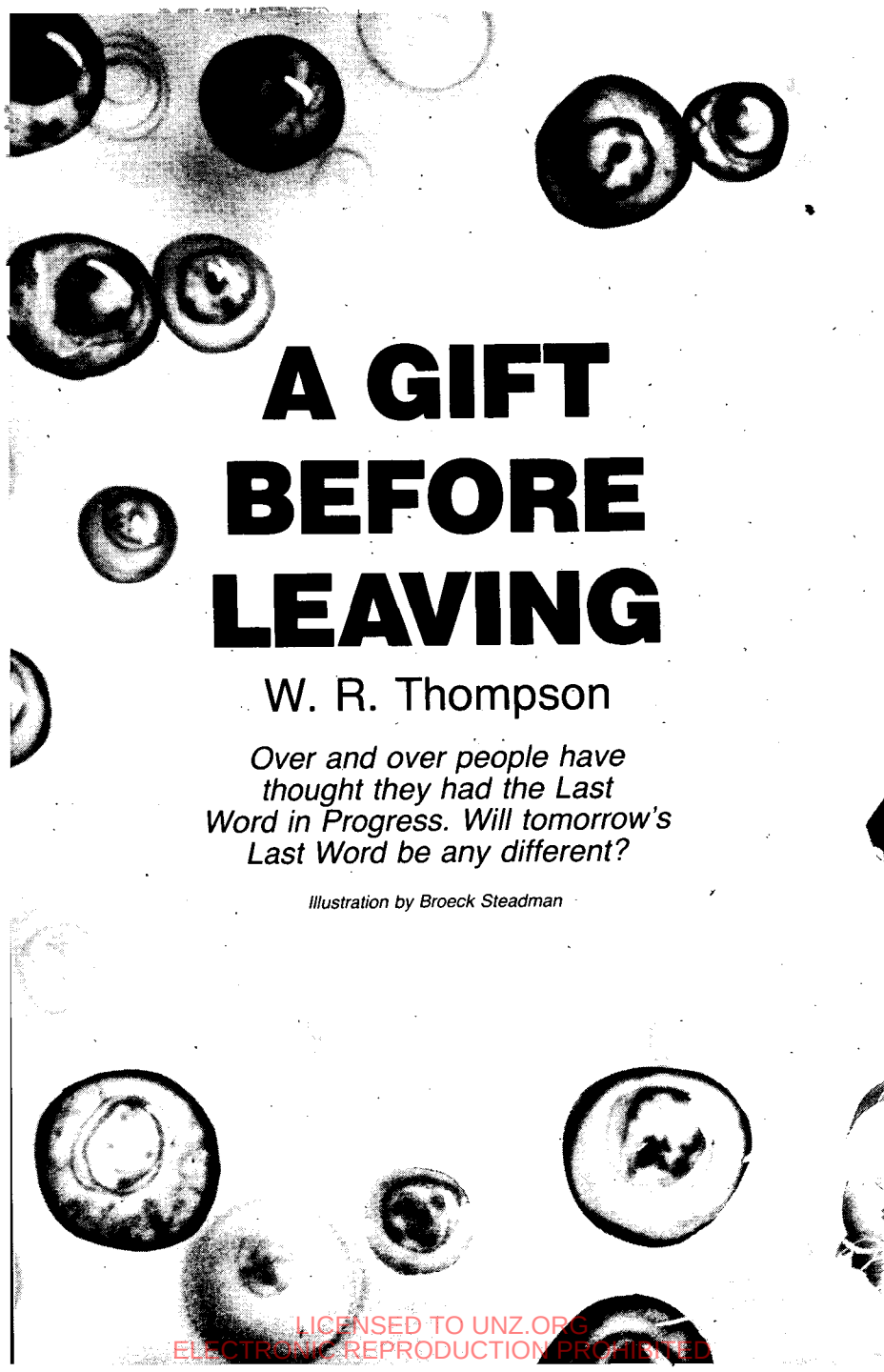

A GIFT BEFORE LEAVING

W. R. Thompson

Over and over people have thought they had the Last Word in Progress. Will tomorrow's Last Word be any different?

Illustration by Broeck Steadman

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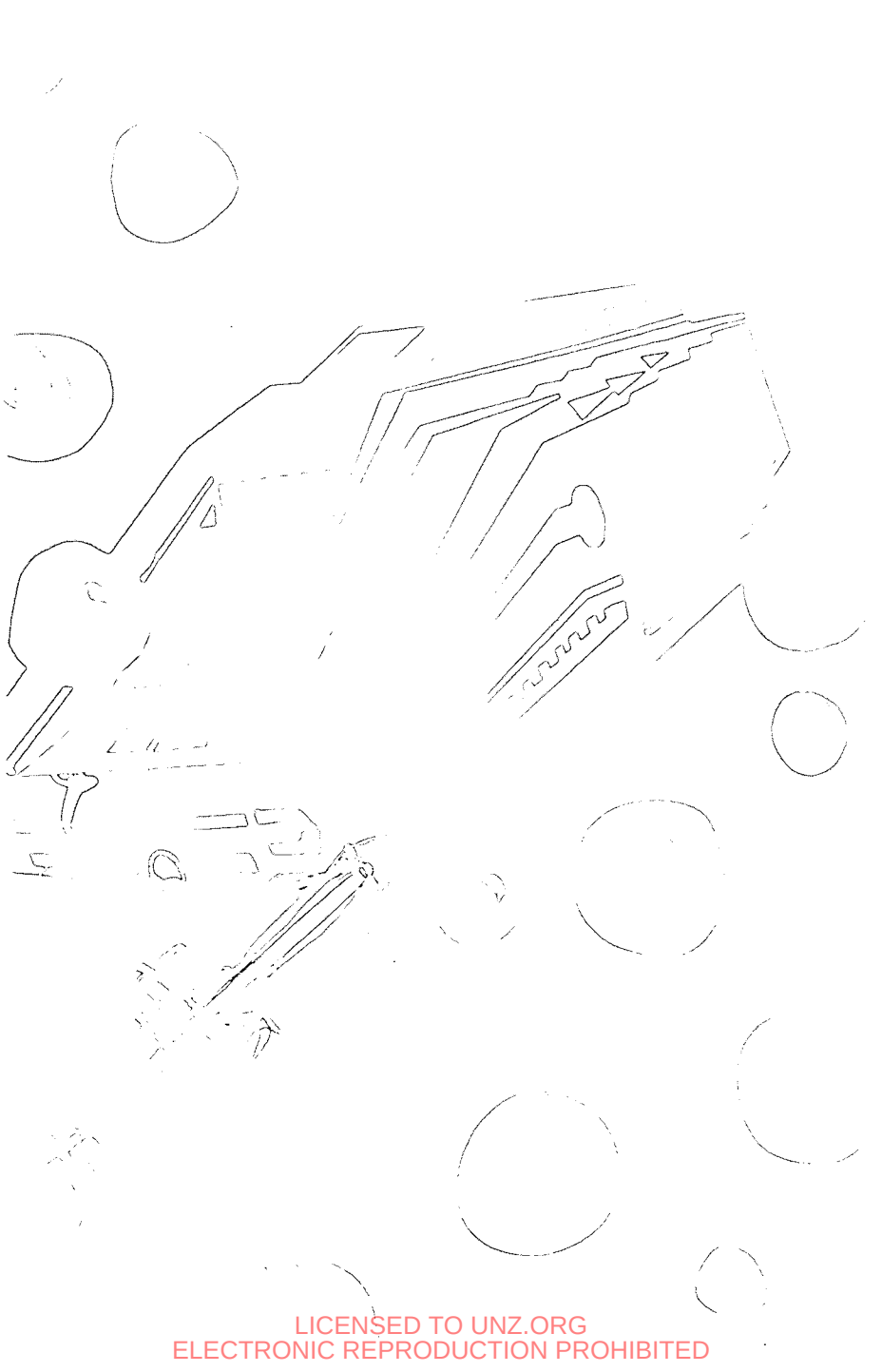

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"We're obsolete," John Taylor said. He sat at his desk and tossed data discs into the wastebasket, one by one. There was a brief blue flash as each quarter-sized disc struck the bottom plate and left reality. "Nobody needs nanotech anymore."

"That's nonsense," Hannah Ruscomb told him. This was not her idea of a good way to start the morning: to come into a half-deserted building and have the boss tell her she no longer had a job. "I've seen the industry figures. Sales are rising, Jack."

"Sales, yes." He frowned as a disc missed the basket and bounced on the carpet. "Development, no. We are, or at least *were*, a development lab. Nobody pays to develop an obsolete technology. And sales are going to start dropping in a few months."

"So you're giving up."

"I'm quitting while I'm ahead. Look at that." Another disc vanished into the basket. "The enemy, right here in my office. I've spent the past six years designing disassemblers that can convert toxic wastes into harmless substances. And what happens? Somebody else does an end run around the waste-disposal problem. Why buy a custom-made microbot to disassemble one specific chemical, when a ten-dollar bucket can turn all your wastes into vacuum fluctuations?"

"I know about quantum tech," Hannah said doggedly. "There are things it can't do."

"The stockholders don't think so," Taylor said. "They're calling a meeting next Monday, and—well, they're going to cut their losses."

"How do you know?" Hannah asked.

"I talked to Jurgens and Post yesterday. Between them they own a majority of our stock, and they've made up their minds. They want to get out of nanotechnology before the market collapses. They suggested I give everyone here their notice and close shop." Taylor flicked another disc at the basket. It missed. "I can't say they're wrong."

"I know Jurgens and Post," Hannah said. "If you really argued with them, they'd change their minds."

"Maybe, but why bother?" A disc bounced into the basket. "What's your problem? We can both afford to retire."

"I'm not ready to retire."

"No?" He looked at Hannah. She knew what Taylor thought he saw: a tall redhead, no longer smooth and slender, on the downhill side of fifty. Old, and by definition obsolete.

Hannah went back to her office, knowing that if she stayed around Taylor she would lose her temper. Maybe I *should* blow a fuse, she thought as she walked down the silent hallway. She'd worked here for five years, and she was—by Taylor's own admission—the best nanotech designer and programmer he'd ever seen, responsible for a third of NanoPlus Incorporated's annual income. She deserved better treatment than this. He had no right—*nobody* had a right to tell her she was useless. It was like declaring her dead.

Hannah sat down with her notepad and typed up a list. There were still jobs for microbots, and profits for the company that developed them. Microbots to convert tar and asphalt from torn-up roads into more valuable forms of petroleum. Airborne mikes, dispersed into

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the stratosphere, to hunt down and disassemble the chemicals that were destroying the ozone layer. Nitrogen-fixing nanomachines to fertilize farms. Devices to find punctures inside tires and repair them before a tire could go flat. Nanotech kitty litter—and why hadn't anyone thought of *that* before?

Her eyes lit up. Why not use quantum mechanics to power microbots? One of the real limits on nanotech was energy; a microbot had to get its power from *somewhere*—sunlight, microwaves, heat, chemical reactions, something. That limited how rapidly a nanotech device could operate, and made it bigger and less efficient than it could be. . . . but a microbot could draw on unlimited power if it could tap the energy bubbling in the quantum foam that made up "empty" space.

After a half hour Hannah had a five-page list, a thumbnail file of proposals for Taylor to show to the stockholders. She printed out the list and took it to his office.

The room was bare. Only the dust on the windowsill and the quantum-tech wastebasket remained. Everything must have gone into the basket, Hannah thought, including the furniture. There was no trace of Taylor himself, and for a moment she wondered if he had followed his possessions into the wastebasket—wait, there was a memo, stuck to the back of the office door. *I'm catching the next plane to Tahiti*, it read. *If you want to tag along, I'll see you at the airport.*

Hannah wadded up the memo and threw it into the basket. She saw it flare as the bottom plate converted the matter into energy, and drained that energy into the quantum foam. Taylor's lucky he isn't here, she thought, or I'd stuff *him* in there.

She picked up the basket and carried it back to her office, where she set it down next to her desk. She dropped several stacks of old trade journals and catalogs onto the floor, then sprinkled a packet of microbots over them. The virus-sized machines went to work on the magazines, and stout cardboard cartons slowly rose from the floor. She played her reading lamp's beam on the floor to speed up the growth.

She was surprised at how little she wanted to save from her office. Wads of memos, tech magazines and outdated manuals went into the basket, along with inkless pens, a used emery board, an obsolete roll of tape, and her old wastebasket. When she had finished disposing of the junk, she put the new cardboard boxes on her desk and loaded them with items from her shelves. She saved her physics and computer texts, along with her design manuals, framed photographs and plaques, the clay paperweight Jo had made for her at summer camp—twenty-five years ago? she thought wonderingly—and her venerable, autographed first edition of Drexler's *Engines of Creation*.

And, of course, her idea list. Now that she no longer worked for NanoPlus, she mused, all those ideas were her intellectual property. They would be an asset when she went job hunting. She put the list into her purse with her notepad.

She filled the last box and folded its top shut. "Follow me," she told the desk, and left the office. The desk stretched its legs and waddled after her.

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It joined her in the parking lot, where Hannah put the boxes in her car's back seat, and emptied its drawers into the trunk. Hannah got into the car, then looked at the desk, which stood beside the car like an abandoned puppy. "Go back to the office," she told it.

She settled back in the seat. "Take me home."

"At this time of day you might prefer the freeway," the car said. "The radio reports little traffic, and—"

"Suit yourself," Hannah said, and the car started up.

Hannah owned a beach house in Balboa, a few miles south from where she worked. She had bought it when she went to work for NanoPlus, and to her surprise she had managed to make the last payment two years later. The house had been expensive even by southern California's standards, but a stream of productivity bonuses had given her the money to pay off the mortgage.

She spent the trip home typing ideas into her notepad, and by the time the car parked itself in her garage she had added two pages to the list she'd started in her office. There's nothing like being fired and angry to inspire you, she thought.

The house and the cat greeted her when she came inside. "Hello, Hannah," the computer said, while Velcro rubbed against her ankle. "You're home early. Are you well?"

"I'm fine." Hannah picked up the Siamese tom and scratched his head. "But I got fired. The company is going out of business."

"That is unfortunate. You must feel stressed."

"I'm just pissed off," she said. "I'll get over it."

"I'm sure you will—" Hannah could almost hear the machine activate a psychological subroutine, "—but a loss of this magnitude is a traumatic event—"

"I don't have time to be traumatized," Hannah said. "I'm going job-hunting. Print out fifty copies of my résumé."

"Consider it done." Upstairs, a quiet hissing issued from her study. "If you want to talk about anything, I'm always here."

"I don't need to talk," Hannah said. The computer's command software was a personality simulator; somebody claimed that the matrix had been pirated from Alan Alda's brainwave trace. There were times when Hannah wished that the machine was a little less aggressively helpful and understanding.

Hannah carried the cat and the list into the front room and sat on the sofa. "Clear the window, please."

"Certainly." The wall which faced the beach was made from layers of electrically conductive glass, currently polarized to block out light. The computer changed its polarization, and the window cleared to show the beach. It was a sunny spring day and a few people were on the beach—an old man with a metal detector and a couple of high-school age surfers who looked like they had cut class. The surf was high today, and she watched the waves break for a while before she went to work.

While the cat dozed on her lap, Hannah added more ideas to her list. Several times she would pause and delete something. There were any number of jobs that begged for a nanotech solution, but some of them were impractical, or un-

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profitable, or both. She wanted to dazzle potential employers, not show them a string of hits and misses.

The house let out a polite chime. "It's almost one o'clock," it said. "Would you care for lunch?"

"Yes, thank you. I'll have the usual."

Hannah put her notepad aside and lifted the cat from her lap. Velcro sank his claws into her dress, and they came away with the tearing noise that had given him his name. The microbots woven into the fabric mended the cloth while she set the cat on the floor.

The cat mewed tiredly and rubbed her ankle again. Poor little fellow, she thought in sympathy as she stroked him. The cat was over twenty years old. Veterinary microbots had cured his arthritis and cataracts, and given him several extra years of life, but he was fading away. His fur was dull and patchy, and Hannah could feel the bones under his loose skin. The vet had recommended putting him to sleep last year, saying he was too old and weary to enjoy life. Hannah hadn't been able to do that. Velcro was a link to better times, to Jo's childhood and her marriage. Besides, she was certain he trusted her to treat him better than that.

Shaking her head, Hannah went to the kitchen, where a pair of ham sandwiches and a glass of milk waited on the counter. She sat on a stool, and was halfway through the second sandwich when the house spoke again. "The mail is here."

"Mmph," she said, and swallowed. "Anything besides junk?"

"Yes, there's a postcard."

"Bring it in."

A servitor rolled in a moment later. Its top flipped open and extended a tentacle, with the mail clamped in its end effector. Hannah sorted out the junk and was left with the postcard.

It was from Brad, her ex-husband. He wanted her to know that he'd moved to Oregon last year, to join a communal farm. The crop was growing well. Sunshine had quit high school to have his baby. Why didn't she come for a visit? Everyone would love to meet her. Warmth and good karma, Brad.

Hannah tore up the card and scattered it on the floor, where the servitor vacuumed up the scraps. "Damn it," Hannah said to the house, "I told you that any mail from my ex was junk mail."

"I'm sorry, but you specified letters. I didn't know that covered postcards."

"It does. It also covers packages and anything else he sends here." Sunshine, she thought in disgust. A commune. She and Brad had been a few years too young to be hippies, back in the sixties, but they both had known what was going on in places like Haight-Ashbury, Woodstock, and the People's Park. They had reminisced about such things while they were married and teaching at a state college, and he had always sounded sorry at missing the fun. What was he doing now, reliving his boyhood fantasies?

Probably, she thought, probably. Six years ago he had quit his job as a philosophy instructor and traded her in on a younger model. The divorce had been bad enough, but the way he carried on afterwards had humiliated her. He'd hung around the college, hitting up on toothsome coeds while the campus gossips snickered at him—and at her, as if

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his behavior was her fault.

Hannah pushed her sandwich away. "Print out a list," she said. "All of the nanotech companies in my Rolodex, and all of the companies that are advertising for anyone in my field. Limit the search to, um, a radius of fifty miles from here." That fifty-mile zone included Silicon Hill and the Silicon Strip, two of the densest high-tech zones in the country. There might be some great jobs in Tokyo or Berkeley or other places, but she didn't want to give up this house. Taylor had upset her life enough without adding a major move to the proceedings.

Hannah took the time to brush her teeth, then went into her study. The résumés were in the printer's bin, fifty sets of three double-spaced pages neatly stapled together. The list of potential employers was much shorter than she had expected. "Something's wrong here," she said. "Why aren't Cyberdots and TikTok on this list?"

"Those companies are no longer in business," the house said. "I removed them from your address book several months ago."

"When did that happen?"

"Cyberdots declared bankruptcy on February seventh, and—"

Hannah sighed. "I suppose that includes Stardust, En-Cubed, California Replicators, and Magic Helix?"

"En-Cubed is still in business, but it is no longer involved with nanotechnology," the house said. "The other businesses you named are no longer extant."

"All right." The truncated list still had twenty names and addresses on it. One of them would have a job for her.

Hannah went to the car, gave it the first address on the list, and looked over her résumé while the car drove. Everything was in impressive order. Her college career and three degrees in physics. Her postdoctoral work on computer modeling of fusion processes. Seventeen years as an associate professor of physics. One year at Caltech to study nanotech design. Five years at NanoPlus, with twenty patents and a steady stream of productivity bonuses and industry awards. Professional references.

General Cybernetics occupied a building in Irvine, ten miles north of Hannah's home. The building's exterior looked like a multifaceted quartz bauble—which it was. The building's shell had been constructed by nanotech assemblers and transporters, which had taken materials from the soil and grown them into a single crystal. Hannah still had her doubts about the process. It only took a week to grow a two-level building like this one, and the costs were low, but she didn't have a high opinion of quartz as a building material.

The building had stood for several years, however, and didn't seem in imminent danger of falling down. She went inside. The foyer was a small room with a computer receptionist. It spoke to Hannah before the door had finished closing behind her. "Doctor Ruscomb?"

Hannah nodded. "That's me."

"Mr. Faulk will see you right away."

That surprised her. "He's expecting me? I didn't call." Dennis Faulk was the president of General Cybernetics; Hannah had intended to see the personnel manager, whom she knew better

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than Faulk. She had met Faulk at Caltech, where they had taken several classes together. She had hardly seen him outside of the classroom, however. The young man had seemed indifferent to everything beyond the new world of nanotechnology, including a fiftyish divorcée. "I'm surprised he even remembers my name."

"Your name is on my A list," the receptionist said. "This way, please."

A glowing line appeared in the crystalline floor. Hannah followed the light down a corridor and up a staircase. She passed several open doors on her way to Faulk's office. Business looked good, she thought optimistically. Men and women sat at desk-sized factory units, where nanotech assemblers took raw materials and built new microbots, atom by atom, loading millions of them like fine dust into tea-bag sized packets.

Faulk's office was a mess. He sat behind a cluttered desk, a chubby man with a submarine sandwich in one hand and a Coke can in the other. "Seat for the lady," he mumbled through a full mouth. "Been a while since Caltech."

"It has," Hannah said, as a chair walked forward and positioned itself in front of the desk. "How have you been?"

"Nominal. Why are you here?"

Hannah tried not to frown. Several years as an executive had not changed Faulk's attitude toward good manners. He could be charming when he had a reason, but by and large he saw manners as a waste of time. "I'm looking for a job in research."

"Taylor went belly-up?" Faulk asked.

"He closed down this morning," Hannah said. "He claims that the nanotech market is drying up—"

"It is," Faulk said. He chomped down the last of his sandwich. "The computer projections say we can expect a nosedive in six or seven months. Things are shaky already."

"You seem busy here."

"Military contracts," Faulk said. "They live forever. We're still making armor disassemblers for anti-tank units, even though nobody uses tanks any more. You want to do research?"

"Yes."

"Me, too. I'm ready to sell this place and jump into quantum tech. Maybe you and I could start something. Between us we could finance a good lab."

"I want to stay in nanotech," Hannah said.

"Why bother?" He finished the Coke and crushed the can in one chubby hand. He tossed the can into his office wastebasket, where it rattled and did not vanish. "Nanotech research is a dead letter. Next year only hobbyists will be in the field."

"Nanotech will still be in use," Hannah said.

"For a while," Faulk agreed. "But that's only because it takes time to switch from one technology to another. You have to design replacements, finance them, train new operators—things like that."

"I know about quantum tech," Hannah said insistently. "It has limitations—"

"So did nanotech," Faulk reminded her. "Quantum tech grew out of research into those limitations, y'know." He looked Hannah over as if assessing her. "If you want to stay in nanotech

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research, why don't you buy me out and set up your own lab? I've got a good staff and good facility here, and you could hire other researchers cheap."

"I don't want to be a manager," Hannah said.

"Who does?" Faulk asked. "But when you're 'boss,' you get to set your own agenda. Nobody tells you to stick to one line of work, or drop another. I know you can afford to buy this place," he added. "Taylor paid well, and you're the sort to invest money instead of squandering it."

"I don't want to go into management," Hannah said, "even for myself. Managing takes up too much time—how often do you get into the lab yourself?"

"Good point," he said. "But you could set up an AI administrator. They have a new personality sim, it synthesizes a mix of Scrooge and Al Capone—perfect management stuff. That's the route I'm taking for my next business."

Hannah shook her head. "Even the best AI system can't do everything."

"True," Faulk said. He looked down at the papers on his desk as if to confirm that—and to dismiss her.

Hannah sighed. Faulk seemed to have gone through a mental checklist. Could he use Hannah as a research partner in a new venture? No. Could he sell the old business to her? No. Then she was no longer useful. She walked out of the office without saying good-bye.

A hunch made her stop in the foyer. "Am I still on the A list?" she asked the receptionist.

The computer hesitated. "May I have your name, please?"

"No," Hannah said. She didn't feel surprised that Faulk had dumped her from his list, or even that he'd done it so quickly. It still offended her that he thought she was so damned disposable.

Hannah went back to her car. It was almost five o'clock; too late to visit the next stop on her list. As her car headed for home she conceded that her job hunt might not work. Everyone in the nanotech business watched the computer predictions, and as Faulk had said, the projections pointed to a sharp downturn in the business.

A downturn, however, was not the same as death. The introduction of quantum technology would not make nanotech obsolete, no matter what Taylor and everyone else thought. The field would adapt to the changes—possibly even find a way to take advantage of them. A smart operator, Hannah assured herself, would take that into account.

She called her home. "Set up a hypertext," she told the computer. "I want a basic instructional path for quantum technology."

"Yes, ma'am," her house answered. "Do you wish to flag any specific databases?"

"Well—I don't know. Start with the standard databases for physics, cybernetics, and electronics. I may add more when I get home. That's all."

Hannah closed her eyes; blocking out the world always helped her to concentrate. Had she missed an important database? There might even be one dedicated to quantum technology. Perhaps, and if there was the computer would trace it down. That wasn't the point, however. She suddenly realized how lit-

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tle she knew about quantum technology. It was just a name and handful of terms that held a vague relation to what she had learned as a physicist, several decades ago. Probability states. Photonic standing waves. N-dimensional energy levels.

The computer was still preparing a hypertext when she got home. "The search has extended through a rather large number of databases," it said apologetically. "I anticipate primary linkage completion in an hour. Would you care to dine while I work?"

"Yes, please. Could you prepare salad, shish kebab, and some wine?"

"Certainly."

There's nothing silly about being polite to a computer, Hannah told herself. Manners were a custom which demanded constant practice, and there was no harm in practicing them on a machine. Perhaps the alternative was to become like Faulk, who was considerate only when he had something to gain. It occurred to her that she knew far too many people who took a practical approach to life, dropping other people when they were no longer useful. Look at her ex-husband, she thought, swapping her for a string of teenage cookies. Look at Taylor. Look at Faulk.

The computer didn't speak again until Hannah had finished her dinner. "The initial work is done," it said.

"Good." Hannah went into the living room, took her display plate from the coffee table and sat on the couch. She put the plate on her lap; she had learned to read with books on her lap, and she still found it the most convenient way to read.

She started with a popular article on quantum technology. As Faulk had said, quantum tech had begun as an offshoot of nanotechnology. Nanotech worked with machines that were the size of viruses, or smaller; on this scale quantum effects became important. Some nanotech designs would not work because the charges in their electron shells caused parts to repel one another; others failed because atoms would combine in unexpected chemical reactions. Atomic nuclei held charges which could disrupt certain molecular configurations. Other shapes destroyed themselves by absorbing energy too efficiently.

Naturally, the article continued, the nanotech industry had looked for ways to overcome these obstacles. The industry had financed research into quantum mechanics, the branch of physics which described the behavior of matter and energy at the subatomic level. The research had paid off with unexpected discoveries. Energy could be pulled from quantum vacuum fluctuations, or pumped into it for disposal. Photons could be caught as standing waves and used to form the circuitry of computers. Certain constants could be varied with profound effects on the state of matter. Probability levels could be biased. Continued next page.

Hannah stared at the plate for a long moment. The computer had highlighted a dozen words which meant nothing to her, or which clearly did not mean what they did in the physics she understood. Hannah put her finger on one highlighted term, and the hypertext software offered her a dozen datasets to explain the term. She chose the first one and continued reading.

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* * *

The house woke Hannah in the morning. "Your daughter is calling," it said.

Hannah sat up, feeling stiff and sore. She had fallen asleep on the couch last night, something she had never done before—well, I was tired, she thought. The sofa had tried to adjust itself, to no avail. "I'll take the call here. Hello, Jo."

"Hi, Mom. I'm going to drop Morgana off a bit early on Friday. Will you be home?"

"I suppose so." Jo usually brought Hannah's ten-year-old granddaughter over for the weekend several times a month.

"Fine. I'll see you around noon, then. 'Bye, Mom." Jo hung up.

Noon? Hannah felt irritated. She loved Morgana, but Jo was taking too much for granted by bringing the girl that early. She ought to call Jo back and tell her noon was too early—no, that would just start a one-sided argument, with Jo telling her why she absolutely had to leave Morgana here early. That wasn't worth the trouble. Besides, Morgana was a good kid—quiet and intense, but fun to have around.

The plate had slid off Hannah's lap during the night. She picked it up and started reading about photonic standing waves, while the hypertext linkages led her through a half-dozen databases. The concept seemed fairly simple. A photon could be trapped between two atoms and held there, if its wavelength was equal to the space between the atoms and the atoms were held in a polarizing field. Only one photon could be held in this trap, and the trapped wavicle could be dislodged by a free photon of the proper wavelength.

This had led to the current revolution in computer design. A matrix, assembled one atom at a time, formed the circuitry, creating pathways for free photons and gaps for trapped photons. The new computers still used binary arithmetic, with filled and empty gaps serving as binary ones and zeroes, but photonic machines were many times smaller and faster than even the best nanocomputer. A device the size of a pinhead could have more computing power and memory space than a human brain.

Hannah read on, and decided that the basics of programming hadn't changed too much. She could adjust to the new technology. She would take that into account in her job hunt.

She went into the bathroom and took a hot shower. It eased the aches left by an awkward night on the couch, but the steaming shower didn't wake her up as thoroughly as usual. Age, she thought. Fifty-mumble wasn't senility, but it wasn't exactly the first flush of youth, either. Both of her parents had developed arthritis in their early fifties. Maybe she ought to visit the doctor soon and have a check-up.

She didn't feel hungry, but after her shower she went into the kitchen and had a glass of orange juice. She put it down half-finished when the cat walked in and demanded breakfast. Hannah fed him; she didn't trust the house to feed Velcro properly. She had tried that once, but every time the cat had howled at something the house had delivered a full bowl of cat food. Velcro had liked that, and he'd gained five pounds by the time Hannah put a stop to it. Hannah had been unable to program the house

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to give the cat a balanced diet, and she finally decided that either the cat could outsmart her programming, or the house itself had a soft spot for cats.

The cat's excess weight had vanished now, and he only nibbled at his food as Hannah left the house. She had the car take her to the Silicon Hill area. Silicon technology was obsolete, and the "hill" was only a low bulge in an otherwise flat area of land, but the name had stuck. The name was almost ten years old, and Hannah wondered if the people who worked in the district kept it out of nostalgia.

The first stop on her list was Digitech, a computer manufacturer. Digitech's fifty employees ran an automated production system which produced a third of the computers sold in the United States. The building was large, and business looked good—very good, to judge by the number of vans parked in its side lot. There were at least thirty of them, painted in Digitech's company colors. Robots were loading cartons through their rear doors.

As Hannah got out of her car she stared at the vans. Where were the tires? The smooth-bottomed vans rested on skids. She could only think that they floated on air cushions, like a Hovercraft . . . except that Hovercrafts were useless on roads. Aside from being noisy, they were hard to handle and took forever to come to a stop.

Hannah fought the urge to wait for a van to drive away. She walked to the front of the building and came to a blank white wall at the end of the sidewalk. She looked at it in annoyance. Doorways concealed by holographs were the sort of cutesy trick you saw at carnivals and overly-fashionable nightclubs.

Hannah walked forward carefully, with one hand out. It slid through the image without encountering any obstacles, and she stepped into a well-lit lobby without any mishaps. As she lowered her hand she saw that the lobby was a square, doorless room. The walls were marked with glowing lines.

A man stood half-submerged in a wall. "The sign subroutine must be down again," he said in disgust. "Jane! Can't we keep that thing debugged?"

"You're the programmer," a woman's voice said. She emerged from a wall, stepped forward and shook Hannah's hand. "Hi, Hannah," she said. "It's been a while since the last IEEE meeting, hasn't it?"

"Four years," Hannah said. She needed a moment to recognize her: Jane Townsend, a short black woman who specialized in nanocomputer circuitry. Her weight had gone down and her taste in clothing had gone up since the last time Hannah had seen her.

"And you're looking for a job."

"Word travels fast."

"Not really," Townsend said. "Taylor went out of business yesterday, and you show up today. You want a job—why else would you show up?"

Hannah suppressed a wince. "I must be pretty transparent."

"No, it's just that a lot of people are looking for new jobs now. And we're hiring anyone who's halfway useful—let's talk in my office." Townsend turned away and walked through the wall.

Hannah followed her into her office. "Isn't that annoying?" Hannah asked.

"The doors? Not when you get used

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to them." The office was equipped with old-fashioned furniture, and Hannah had to seat herself. "We build door generators, so it's good advertising. Besides—" Townsend smiled impishly, "—like the bumper holos say, hi tech is fun tech."

"How do they work?" Hannah scrabbled through the little she knew about quantum technology. "Is it a phase shift?"

"No, that would destroy the wall material. Have you read Zalinsky's paper on Planck levels?"

Hannah shook her head. She knew the name, but only as a hypertext path she hadn't followed. "Not yet."

Townsend frowned slightly. "Zalinsky found that Planck's constant can have different, discrete values. Normal matter—" she rapped her desk with her knuckles "—exists in a ground state where the constant has its usual value, six-point-whatever times ten to the minus-thirty-four joule-seconds. That gives each particle a basic uncertainty about its own location. We can raise matter to higher states where Planck's constant has a much higher value. At *h* equals five, the uncertainty is so great that an atom can be anywhere in the Solar System."

"So your generators make a part of the wall vanish," Hannah said.

"Just the parts that are touched by authorized people," Townsend said. "A computer controls that. Otherwise you'd have all sort of things coming in—dust, rain, burglars, and other pests—and your wall would vanish every time the wind blew on it. The transition is unstable, and once the user is through the wall returns to the unexcited state in a few milliseconds."

Somebody seemed to have changed the basic definition of uncertainty, but Hannah couldn't deny that it worked. No matter now; it was time to prove she could be useful here. "What's your market?" Hannah asked.

"Security, for the most part. Burglars can't get through our doors, and dishonest employees can't carry pilfered merchandise through them."

"Do you make safes and bank vaults?" Hannah asked.

Townsend looked surprised. "I never thought of that. Can I get you to sell that idea to me?"

"I can always use the money," Hannah said, while Townsend typed a few words into her desk notepad. "But I want to ask what sort of a job I could get here. I'm sure you still use nanotech somewhere."

"No, not directly," Townsend said.

"You mean 'not at all,' " Hannah said, seeing the careful expression on Townsend's face. The woman looked as if she was searching for a delicate way to break bad news. "Jane, am I wasting your time?"

"Not when you just gave me an idea for a new market," she said. "The whole industry is in a mess, and we need all the business we can drum up. If you can think of anything else like this, I want you to call me right away."

"But you can't hire me."

"Hannah, you have a Ph.D. in physics. If you can take six months to retrain, bring yourself up to date, we could use you." She frowned. "Assuming we're still here in six months. Everything is changing so fast that we're doing the Red Queen's race, run-

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ning twice as hard just to stay where we are."

"I see." Hannah stayed a few minutes longer, but there was no mention of a job.

The bar was neither seedy nor elegant; it simply *was*, in a way that made the outside world irrelevant. Hannah sat at the bar and scowled at her bourbon. After her visit with Townsend she had gone home and checked some industry figures. Nanotech research wasn't just in a slump; it was in its grave. The companies that remained in operation were scaling back their research, when they bothered to maintain it at all. A nanotech designer wasn't even halfway useful—that had been implicit in what Townsend had said.

She gestured to the bartender to refill her glass. He was a generic bartender, a middle-aged man with thinning black hair. She'd heard somewhere that bartenders were good listeners, and she felt like talking. "I've noticed something about myself," Hannah told him.

"What's that?" Bourbon splashed into her glass.

"I don't notice things."

"What sort of things don't you notice?"

"Job. Husband. Changes." She looked across the bar, where the washer was busily cleaning used glasses with its tentacles. "I used to design those."

"What, dishwashers?"

"No, microbots. That's what they use in the tentacles," Hannah said. "Simple ones, shaped like a spring, thick as a hair. Can bend themselves into any shape, even tie themselves in knots. Bundle a few thousand together, wrap 'em in a friction coat for grip, and you have a tentacle."

"And you don't make them any more?" the bartender asked.

"Nope. They're obsolete. So's ev'rything I know about them. Just like your dishwasher."

"Obsolete? I've never had any problems. What's wrong with it?"

"It's not up to th' minute. Next year's—next *week's* model will prob'ly make the dirt vanish into th' quantum fluc'tions—" She grimaced; the bourbon was hitting her now. "—fluc-tu-ations. Or change probability so the glasses were never dirty in the first place."

"It sounds interesting."

"Maybe. It's the kinda thing cost me my job. Change. Progress. Di'n't even notice it was happening." She drank half of the bourbon at a gulp. "Should've noticed, you know? Cars don't have wheels now. Don't need t' empty wastebaskets or flush toilets. Only I wasn't paying attention."

The bartender shrugged. "Except for Sherlock Holmes, who notices everything?"

"I'm not sure I notice anything. Husband wandered off. Job went away. Wonder what else I haven't noticed?"

"You talk like you think it's all your fault."

"It is," Hannah said. "Not noticing, I mean. If I'd noticed how much, how fast things were changin', I could've found a new job. Instead I got a bucket of ice water in the face." She hiccuped. "Pro'ly what I need now, anyway."

"What you really need," the bartender said, "is to stop blaming yourself for things you can't change. Guilt is the

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most useless and destructive thing there is." Somebody asked the bartender for a doppelganger. "Think about it," he said, and went away to mix the drink.

Feel-good sermon number fifty-two, Hannah thought sourly. She didn't like it, although she was too drunk to find the reason. Hannah waved a credit card over the counter, let the bar read it, and left.

The dashboard blinked a red light at her as she got into the car. "I'm sorry to say this, ma'am," the car said in its most deferential tone, "but your blood-alcohol level is—"

"I'm *drunk*," Hannah told it.

"—above the legal limit for manual driving. I am now locked in autopilot mode, in accordance with—"

"Just take me home," Hannah said.

The legal notification played out and the car started. It was time to admit defeat, Hannah thought. The nice thing about getting drunk was that it forced her to stare that fact in the face. She was not going to find a job in nanotech. It was time to switch professions. Hannah had done that before, and by God, she told herself angrily, she wasn't too old and inflexible to do it again. She would prove that. She had already started by studying quantum technology.

After the car parked itself in her garage, Hannah staggered into the house. "Sober me up," she said.

"Certainly, ma'am," the house said. The kitchen went to work and mixed a glass of enzymes. Here's to nanotech, Hannah thought as she drank the glass. The designer enzymes entered her bloodstream quickly, where they began converting ethanol into water and carbon dioxide. By the time Hannah reached the living room couch she was breathing hard to get rid of the carbon dioxide.

The cat curled up on her lap as she picked up the computer plate. She looked up Zalinsky's paper, but the muzziness in her head made it impossible to follow the talk about ground states, most-probable-existence radii, and density functions. Still drunk, she thought, seeing her hands tremble. She was about to ask the house for a second glass of enzymes when she passed out.

"How do you feel, Ms. Ruscomb?" a man's voice asked.

"Not bad." Hannah tried to raise her head. It took more effort than it was worth. "But not great. Where am I?"

"This is the UC Irvine Medical center," the man said. "Call me Otto. Do you feel any discomfort?"

"No, I'm just a bit weak." She looked around the room. It looked like a standard hospital single. There were no tubes or needles in her arms, no electrodes glued to her skin. It can't be too serious, she thought.

"The weakness may pass," the doctor told her. His looks and demeanor seemed calculated to reassure patients. Hannah decided that he was a personality simulator; his name sounded like a cybernerd's feeble pun on *automatic*. When she looked she saw that the doctor cast no shadow on the tile floor. "You've been ill, but we have you stabilized now."

"Fine," Hannah said. "What's wrong? Alcohol poisoning?" She felt a bit hung over, which was no surprise.

The holograph gave her a reassuring

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chuckle. "Don't let yourself worry. All of your vital signs are fine. A doctor will be here very soon to discuss your condition with you."

In fact the doctor did not arrive for over an hour, and he proved to be a young man named John Park. He consulted a clipboard and a set of medical instruments before he spoke to Hannah. "How are you feeling, Ms. Ruscomb?"

"Annoyed," she said. "I want to know what I have and what's going on. I don't remember checking in last night."

Park nodded. "You have a liver condition. You passed out last night. Fortunately your house called for help in time and we got you stabilized. You're responding well to treatment."

"What's this 'condition'?" Hannah asked.

"It's cancer," Park said. "You're stable now, and the tumors aren't spreading. Our treatment uses nanotech DNA disassemblers, which—"

"I know about them. I used to design microbots."

"Then you probably know more about them than I do," Park said. "You'll be able to go home in a few hours. We'll continue to treat you as an outpatient, and we've implanted a monitor to alert us to any degenerative changes in your health."

"OK, fine," Hannah said. "Can I get something to eat now? I'm starving."

An orderly brought her a tray a few minutes after Park left. Hannah picked at the food. It was only cancer, and doctors had been curing that for *months*, but it was going to waste her time and energy for the next week. She resented that.

Hannah finished eating and took a nap. She woke after noon, and told herself that she already felt better. She could picture the microbots in her body as they conducted their search-and-destroy mission against the tumors. Their shells were synthetic antibodies, keyed to detect and latch onto the membranes of cancer cells. Each shell contained a DNA disassembler which it would inject into the target cell, killing it by destroying its nucleus. Each microbot was a one-shot device, but the microbots could easily outnumber the tumor cells.

A hospital clerk came into her room with a clipboard of papers. "We need your signature, Ms. Ruscomb," he said. "Could you look these over, please?"

Hannah took the board and leafed through the papers. The forms were already filled out with her personal information. "Who did all this?" she asked.

"Your house computer faxed us the data," the clerk said. He sounded a little anxious. "We've been treating you as an emergency admission, but the administrators want your signature as soon as we can get it. Aside from getting your insurance company to pay your fees, they're concerned about liability."

Hannah signed the forms. After the clerk left she got up, found her clothes in the room's closet, and dressed. She felt a bit shaky, and the mirror showed her that she had a touch of jaundice. That annoyed her, but she knew it would pass in a few days. At least cancer wasn't something incurable, like the common cold.

A new doctor came into her room, a

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dark-haired woman about her own age. "I'm glad to see you're up and around, Ms. Ruscomb," she said. "I'm Bella Siebert, senior oncologist. Would you mind sitting down while I examine you?"

"All right." Hannah sat on the bed while the woman waved a medical reader over her. The device could not be as sophisticated as the larger units in the room, and Hannah realized that the doctor had merely wanted to have her sit down.

Siebert switched off her reader after a moment. "We've contained the tumors now," she told Hannah. "The ones in your left kidney, pancreas and large intestine are gone—"

"I thought it was in my liver," Hannah said.

"Your liver cancer had metastasized," Siebert said. "That's still there, unfortunately, but it isn't spreading."

Hannah sighed impatiently. "How long will it take to get rid of it?"

"That's the problem," Siebert said. "The prognosis is never excellent with liver cancer, partly because the liver is such a sensitive, critical organ and partly because liver carcinomas can grow so rapidly. Doctor Park told me you're a nanotech specialist?"

"That's right."

"Then you know there are limits on what we can do with disassemblers. The chemicals in the microbot shells are poisonous—which is typical of almost all medicines, by the way—and that limits the dosage we can give you. At the moment you're receiving the MSD, the maximum sublethal dosage, so we can't give you any more."

Hannah's hands tightened on the edge of the bed. "You haven't answered my question."

"I can't," Siebert admitted. "Right now, the tumors in your liver are growing at a rate which the microbots can just barely handle. They're like two evenly matched armies. If the rate slows down, we'll have the edge and we can push them back."

And if the rate increases, Hannah thought, I'm dead. She had always thought that such a discovery would panic her, but it left her feeling oddly detached. "Are there alternative treatments?"

Siebert shook her head. "Surgery is impossible—there are too many carcinomas. Removing all of them would destroy your liver."

"What about radiation and chemotherapy?"

"Radiation would damage the microbots—and microbots *are* chemotherapy." She waved a hand. "Oh, we could dredge up some of the older chemicals, but they wouldn't be as effective as microbots and they would force us to lower the microbot dosage."

"So I'm already getting the best possible treatment."

"Yes, exactly. And your situation isn't as bad as it would have been last year. Nanotech therapy is a mature technology—which I guess you know." After that, the doctor discussed Hannah's treatment. She would have to medicate herself every six hours, avoid certain foods and drinks, avoid exertion, visit the outpatient clinic once every three days. Take certain medicines with food and drink; take others if she had an upset stomach or mild fever or pain. The microbots would have to be

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injected into a vein or artery. Call the hospital at once if she had any problems, and don't worry.

Hannah checked out of the hospital, then visited its pharmacy and picked up a depressing collection of bottles and disposable injectors. As she walked out of the hospital lobby she called home. "I need a ride," she told the house computer.

"Your car is already there," the house told her. "It is near the main entrance of the hospital parking structure."

"Thank you. Could you feed the cat, please?"

"I've already fed Velcro, ma'am. Under the circumstances it seemed the proper action."

"It was. I'll be home in a while."

Hannah found her car in the hospital's basement parking structure. The walk was not long, but she felt herself weakening. The doctor had warned her that she would not have much energy, and she felt drained as she sat down in the car.

Hannah was halfway home when she remembered something. She got out her phone and called her daughter's office. "Jo?"

Her daughter sounded impatient. "Mom, I can't talk now. I have a meeting in a few minutes."

"This won't take long. I can't take care of Morgana this weekend."

"What do you mean, you can't? I have to go to Portland this weekend. What am I supposed to do with her?"

"You'll have to make some other arrangement—"

"Damn it, Mom, why can't you do this for me?"

"I'm sick," Hannah said, taken aback by Jo's barely-contained anger. "I have cancer."

"Well, how serious can that be? They've got a cure for it."

"I'm being treated," Hannah said, "but they don't know how long it will take. And the treatment is really wiping me out."

"Are you going to be all right, Mom?"

What was she supposed to say? "The doctor didn't give me any exact odds. They have me pumped full of medicine, and they're keeping an eye on everything."

Jo sighed. "Mom, I really have to go to this meeting now. I'll call you back as soon as I can."

"OK. Goodbye, dear."

The car took Hannah home, where she went upstairs and lay on her bed. She must have fallen asleep, because the next thing she knew she heard a voice mumbling something indistinct. She sat up and saw the paper bag with her medicine lying on the quilt. She dug into the sack and pulled out an injector. "It is now six o'clock on Wednesday, May seventeenth," the white cylinder said. "It is time for your microbotic injection. It is now six o'clock—"

"OK," Hannah said. "I hear you."

The injector hesitated, the sign of a limited AI chip. "Do you require directions?"

"No." The doctor's instructions had been clear enough. She took the injector, twisted its safety catch and held its business end over the inside of her elbow. She moved it around until a green light came on, telling her its sensor had found a vein. There was a snap and a

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sting as the injector sprayed its contents into her bloodstream.

"The dosage has been properly delivered," the injector said. "This unit will now dispose of itself to prevent resale or reuse." The syringe disassembled itself.

Hannah carried the rest of her medicine down to the kitchen. While the house got her dinner ready, she went to the living room and sat down with the display plate. She tracked down information on cancer-fighting microbots with all the determination of a microbot hunting a cancerous cell.

Hannah did not like what she found. As the doctor had said, medical microbotics was a mature technology, which meant there was no room for major improvements. The tiny machines doing battle in her liver were about as efficient as they could get, and minor improvements were unlikely to improve her odds of survival. She couldn't tell from the data she found if she had any real chance of survival.

What about quantum tech? she wondered. She found references to experimental work and studies. There was a data-analysis technique which could tell the difference between healthy and cancerous cells. It was possible to target cancerous cells with this technique. Regrettably there were no quantum-tech weapons to use the technique; microbotic therapy was so good that nobody felt an urgent need to develop new cancer cures.

Well, she didn't seriously think the microbotic therapy would fail. Give her a few more weeks and she would be fine—and still in need of a job. Hannah decided to take her survival for granted and concentrate on coming to grips with quantum technology.

A servitor rolled up to the couch. It extended a manipulator which held a small bottle. "The wexabine bottle told me that you are to take one of its pills now," the house said.

"Thanks." Hannah reached for the bottle and took out a little blue pill. "I want to order some equipment. Are there any computers on the market that use quantum technology?"

"Yes, there are at least thirty-seven such units. If you are seeking a replacement for me—"

"I'm not," Hannah said. Had that been concern in the house's voice, or was it her imagination? "Could you network with any of them?"

"Yes, there are at least eight units available with which I would be fully compatible. If you are seeking to enhance my capabilities, the SCR-200 would be the most appropriate choice."

"I'm seeking to learn how to handle a quantum-tech system," Hannah said.

"Then the SCR-200 is still the optimum choice. Your dinner is now ready."

Hannah sat down at the table, and discussed the new computer with the house. The talk took her mind off eating, which was an effort; her stomach rumbled but she had no real appetite. She went to bed while the house handled the details of purchasing the computer.

The display plate was suppose to be glare-proof, but the Friday morning sunlight washed out its display. Oh for the days of hard-copy manuals, Hannah thought as she sat on the beach in front

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of her house. A fully-indexed text was easier to handle than a set of books, but you could read books in the full sunlight, jot notes in the margins, and never give a thought to what would happen if the battery died while you were halfway through a page.

The instructions for the SCR-200 fascinated Hannah, and she could almost forget her feeling of lassitude as she read them. The machine had arrived yesterday, and while the house computer had mastered its use through a brief handshaking routine, Hannah needed much more time to learn how to use the new system. It would be worth the effort, though. The SCR-200 had an input device which could sense brainwaves, and an experimental psychoreceptive software which could take commands from them. It was an advanced programming tool and it had almost doubled the system's price, but Hannah was eager to try it.

"Grandmaw!"

Hannah looked up and saw her granddaughter, redheaded and skinny, running across the sand to her. She saw Jo's Porsche parked on the street. Jo got out and lifted her daughter's suitcase out of the trunk. Hannah gave the ten-year-old girl a hug, then sent her off to play on the beach. It was deserted, leaving the expanse of sand and three-foot waves all to her.

Hannah went to Jo and met her at the front door. "I told you I can't take care of her now," Hannah said quietly.

"I couldn't find anyone else on such short notice." Jo put the suitcase on the doorstep. "I've already told Morgana that you're sick. She won't be a problem."

"That isn't the point," Hannah said. "I have just barely got enough energy to sit around, and I have to see the doctor on Saturday morning."

"Morgana knows she may have to help you," Jo said. "Mom, this meeting in Portland is important, and I can't afford to miss it. I have to be at the airport in less than an hour." She turned and hurried to her car.

She didn't even ask how I am, Hannah thought as she drove away. That was another item to add to her never-noticed list, she thought: Jo's selfishness. Hannah *had* noticed it before, but until now she had never realized how deep it ran.

Taking Morgana's suitcase into the guest bedroom seemed to drain most of Hannah's strength, and she had to sit down for a few minutes before she went outside again. When she emerged onto the beach she found Morgana sitting on her beach chair, reading the computer manual, the surf and Sun forgotten. "Did you get a new computer, Grandmaw?" she asked.

Hannah nodded. "Do you want to see it?"

"You bet." Morgana got off the beach chair and ran ahead of Hannah into the house.

The quantum computer looked like any other laptop, a small keyboard with several input/output ports and a holo projector. Hannah kept it on the coffee table in front of the living room couch, and Morgana took it as they sat down. She turned it on and the projector created a display screen. "It boots in fast," Morgana said.

"The CPU is always on," Hannah said. The cat crawled onto her lap, and

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she stroked it idly as she talked. "It's built up out of individual photons and atoms, and if it ever turned off it would all collapse."

Morgana considered that. "Like a balloon when you stick a pin in it? What happens when the power goes out?"

When, not if, Hannah noted with a smile. Morgana, the budding cybernetician, was already acquainted with Murphy's laws. "The CPU is self-powering," Hannah said. "It draws power from vacuum fluctuations. Do you know how that works?"

"Space is like a foam," Morgana said. "There's energy in the holes, and it can pop out as virtual particles—pairs of particles and anti-particles. A vacuum power system catches the pairs and annihilates them before the foam can reabsorb them."

Close enough, Hannah thought. "You know a lot about it."

"It was in *Scientific American* a few months ago. Only they said it would be ten years before anyone could make it work." The girl shrugged as if used to the errors of adults.

Hannah watched Morgana play with the computer's demonstration software. The holograph was creating a fractal landscape when the house spoke to her. "It's noon, ma'am. Your schedule requires an injection now."

"All right." Hannah put the cat aside and went into the kitchen, where one of the injectors muttered its announcement. Hannah gave herself an injection, and when a bottle called for her attention she took a pill.

She saw Morgana watching her from the kitchen entry. "Mom said you have cancer."

"I do."

"Are you going to die?"

"No, of course not."

"You look tired."

"I am," Hannah admitted. "The medicine makes me sleepy. Will you be all right if I take a nap?"

"Sure. I can talk to the house."

Hannah spent Saturday morning at the hospital. The microbots did not die cleanly; after each one shot its disassembler into a cancerous cell, it left the fragments of its shell in Hannah's bloodstream. The fragments were toxic and had to be removed by a dialysis machine. Hannah felt better after the treatment, even though the staff oncologist told her that the tumors were not receding.

The beach swarmed with people when Hannah got home. The crowd would be thicker in the summer, when the California weather turned furnace-hot, but the balmy May weekend had already brought out a healthy number of families and high-schoolers.

Hannah went into the house. She found Morgana in the front room, intently staring at the new computer's display while the cat dozed next to her. "I thought you were going to go out and play," Hannah said.

"There wasn't anyone to play with," Morgana said. "Watch this, Grandmaw."

Part of the display formed a screen, and a simple equation appeared on it: *2 * 2 = 4*. After a few seconds it changed: *2 * 4 = 8*. Then: *2 * 8 = 16*, followed with increasing speed by *2 * 16 = 32, 2 * 32 = 64, 2 * 64 = 128* . . .

The equation had flickered up to *2 **

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134217728 = 268435456 by the time Morgana stopped. "You figured out how to use the psychoreceptive software," Hannah said.

"A little," her granddaughter said. "That was just two times *n* equals *n*, stepped over. I still can't do anything complicated with it."

Still, Hannah thought. The girl hadn't even heard of psychoreceptive software yesterday. Everything in the world seemed new to children, Hannah realized with envy, and change could never take them by surprise. "What's your idea of 'complicated'?" she asked after a moment.

"A fractal landscape," Morgana said. "I can't get that right."

Hannah guided Morgana through a simple program. It was not easy—the software was designed for professional programmers, not casual users—but Morgana stuck with it, her thin face set intently on the display. She continued to plug away when Hannah paused to take her medicine, and by the time Hannah had finished with the injection and a quick snack to hold down several pills, Morgana had a working program in the computer. The image it created was not as sophisticated as the ones made by the demonstration software, but Morgana looked pleased with her success. "I can make it better," she said.

"Not now," Hannah said. She was starting to tire; she needed rest. "You ought to get outside and have some fun."

"I'm having fun."

"I mean get out and play," Hannah said. "It's a beautiful day and you've got the beach out there. And your bellyboard is still in the garage. Why not have a good time?"

"Are you going out?"

"No, I have to take a nap. Give me an hour and we'll do some more work."

"OK." Morgana gave her a kiss and went outside. Hannah lay down on the couch and went to sleep.

She never knew what woke her. She sat up, and shook her head to clear it of grogginess. "Morgana?" she called.

" 'm up here," the girl answered.

"She's in the upstairs bathroom," the house added.

"Thanks." Hannah went upstairs. Morgana was peering into the mirror over the sink, and dabbing at her nose and mouth with a wet washcloth. There was blood on the front of her T-shirt. "What's wrong? What happened?"

"Got in a fight." Her voice was blurred by her swollen nose.

"Why? Who hit you?"

"Some stupid kid. They wanted to bury me in the sand."

"They were playing."

"Well, it wasn't any fun."

Hannah went to the kitchen and made up an ice pack. She had Morgana lie on the couch and hold the pack to the side of her face until her nosebleed stopped. Then she had the house prepare dinner—hot dogs, french fries, chocolate pudding, and chocolate milk: Morgana's favorites—and while they ate the girl told her what had happened. There had been a lot of kids on the beach and she had tried to play with them, but some of them had told her to stay away and the others had wanted her to do stupid things.

"Girl-things?" Hannah asked. That had always irked her when she was a kid: everyone had expected her to do

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the things a girl was "supposed" to do.

"*Stupid* things," Morgana said. "Like making sand castles where the waves can hit them, or pretending we were pirates when there haven't been any pirates for hundreds of years."

"They're just games," Hannah said.

"They were still stupid," Morgana said. "So I went to play with some other kids, but they wanted to bury me in the sand. When I said no they started throwing sand at me, and I started throwing it back and then we started fighting."

"What's wrong with getting buried in the sand?"

"It makes you all cruddy," Morgana said.

"You got covered with sand anyway. You'd better take a shower when you're done eating."

Morgana nodded. "Then can I play with the computer?"

The house woke Hannah at dawn on Monday morning. There was something she had to do . . . medicine? No, Morgana. Jo had called last night and said she would pick up her daughter on Monday morning. She had to stay a bit longer in Portland, or something. Jo had been very vague. Hannah recognized the smokescreen from Jo's teenage years: Jo had a new boyfriend, and wanted some extra time with him.

Hannah had the house cook breakfast while she woke Morgana and got her dressed. The girl was still eating breakfast when the house told Hannah that Jo's Porsche had just parked out front. "Finish your breakfast," Hannah told her granddaughter. She wanted to see her daughter alone.

Hannah stepped onto the front porch and closed the door behind her. The house took the hint and kept the door closed. "Morgana got in a fight on Saturday," Hannah said, after Jo joined her on the porch.

"That happens sometimes," Jo said. "Other kids pick on her."

"There's more to it than that," Hannah said. "She told me a few things after the fight, and I talked to her a lot yesterday. She doesn't know how to get along with other kids. She—"

"She's fine," Jo said.

"She's a ten-year-old kid who'd rather talk to a computer than play on the beach."

"She is *fine*," Jo insisted. "Mom, if I want to hear crap about how to raise my daughter, I'll listen to those idiot counselors at her school."

"All I said—"

"All you were saying was that I don't know how to raise my daughter! I've taken care of her since Richard walked out and I don't need anyone telling me what to do."

"You're not the only one in this family who raised a daughter," Hannah said. "I—"

"Here we go again," Jo said acidly. "Another one of your full-time-career-mommy stories. I've already heard them. I'm *living* them. So save it."

Hannah fought down an urge to slap her. "If you're doing such a good job, why doesn't she have any friends?"

"That's right, you know everything, don't you? No wonder Dad left you!"

The front door opened before Hannah could say anything. "I'm ready to go now," Morgana said. " 'Bye, Grandmaw."

Jo said nothing as she took her daugh-

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ter to the car and left, and Hannah didn't trust herself to say anything in front of Morgana.

Hannah went back inside, so angry that she almost forgot how tired she felt. I raised her, she thought. I raised a daughter who is so self-centered that she hardly cares about her own daughter's welfare. Now Morgana is paying for my mistakes with Jo.

She remembered what the bartender had said, that guilt was useless and destructive. Wrong, she thought. Guilt was the force that made you want to correct your mistakes. But how could she correct the mistakes she had made with Jo, before they ruined Morgana's life?

There was no answer. That did not mean she could stop looking for one.

Hannah had a dialysis treatment on Tuesday, and another one on Friday. She went into the treatment weak and logy from the accumulated poisons; she came out feeling reasonably healthy, a sensation which lasted the rest of the day. After both treatments, Siebert, the oncologist, reported that the carcinomas were not advancing, but she would not share her information with Hannah. Hannah hated being kept in the dark.

The week and weekend both passed without a call from Jo. That meant nothing. Jo's temper had flared up before, and Jo had always apologized for her outbursts when she needed anything from her mother. She would call again, as soon as she needed someone to take Morgana off her hands for a few days.

Hannah continued with her studies. She sampled quantum technology, and searched medical databases for new cancer treatments, but she concentrated on learning to use the new computer. The psychoreceptive software fascinated her. It was not a gimmick; it was designed to allow humans to form mental links with computers, vastly enhancing their own mental powers.

A note in the operator's manual hinted that this computer might not be the ultimate in circuit technology. It was possible for clusters of photons to trap one another and hold themselves in dynamic, resonant structures. In theory there was no limit on the upper size of such a structure, although so far only simple, unstable lattices of photons had been built this way, using pulses of photons emitted from quantum-computer circuits. Such experiments implied that a computer might be constructed of pure energy.

Hannah spent an afternoon studying the theory which had suggested that. In the end she could not decide if the notion was outrageous enough to be true, or merely outrageous.

Hannah walked into the hospital on Monday morning, almost exactly one week after Morgana's departure. She carried the quantum computer in one hand. A clerk processed her entrance, and a nurse took her into a therapy room. "I'll have to ask you to turn that computer off," the nurse said.

"I wanted to get some work done," Hannah said.

"It's hospital regulations," the nurse said. Hannah shrugged and turned off the display unit. Then she lay down on the bed. The nurse stuck arterial needles into her arm, connecting Hannah's bloodstream to the dialysis machine. She watched saline solution and blood course through the tubes.

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After a while Dr. Siebert came into the room, accompanied by a nurse who pushed a cart. The cart held the oncologist's instruments, and after a minute's fiddling with the devices she scanned Hannah's body. "How am I doing?" Hannah asked her.

"You're holding your own," Siebert said.

She was studying a holo display, hidden from Hannah by the cart. "Mind if I have a look?" Hannah asked.

"There's really nothing for you to see," Siebert said.

"All right." Hannah thought a chain of thoughts which were not words. Her computer began a preprogrammed search. "What does it look like?"

"You're doing quite well," the oncologist said. "The tumors haven't grown by an appreciable amount, and the remainder of your liver tissue appears healthier than it did when you started your treatment. We won't make any changes in your treatment."

"Fine." Hannah closed her eyes and dozed.

She felt better when she woke up. She took her computer, checked out, and went to her car. While it drove her home she checked the computer's files. Yes, its cellular modem had tapped into the hospital's computer net. It had accessed and copied a number of files, including the datastream from Siebert's instruments. Hannah had to wait until she got home to read the files, which were encrypted to maintain the hospital's privacy.

When she got home she flopped down on the couch and let the house computer work on the files. The hospital used a standard encryption system, but there were so many systems in use, with so many positive keys, that the computer needed almost half an hour to decipher the files. "I'm done now," it said at last.

"Good. Give me a false-color image of my insides. Highlight all tumors in orange."

"I have a number of image files. Which shall I use?"

Hannah spent the next hour looking at images and charts. At the end of the hour she was satisfied that the tumors were not spreading, which was good . . . but the ones the microbots had stamped out had been replaced by new growths. The medical stalemate continued.

At least she wasn't losing ground. She leaned back on the couch, and as she did that she realized something was wrong. It took her a moment to put her finger on a certain absence. "Where's Velcro?"

"The cat died at 2:16 this morning," the house said.

Hannah felt stunned. "Dead? He—where is he?"

"The cleaning system removed the cadaver," the house said.

"You—you let a bunch of microbots disassemble him?"

"A cadaver is a potential source of infection, and—"

"Shut up!" Damn it, she told herself, Velcro had deserved better than to be chucked out like garbage. "What would you do if I died?" she demanded. "Disassemble me, too?"

"No. I would notify your physician, next of kin and—"

"Never mind."

"If my removal of the dead cat was

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incorrect—"

"Shut up. Just shut up." She started crying. The problem wasn't Velcro, she realized. It was herself. She wasn't much further from death than the cat had been. Had the cat died with regrets and things undone? Who would come to her funeral? There was Morgana, and Jo, and who else? After Brad dumped her she had let her old friendships fade, because they were painful reminders of the past, but she had cultivated no new friends. It occurred to her that she had met all of her old friends through Brad. He was the one with the outgoing personality, while she—

It's like a family curse, she thought suddenly. We're all selfish about sharing ourselves. I get so wrapped up in work that I don't notice the world around me. Jo's good with her work, but not people. Morgana is becoming a monomaniac. She wanted to lift the curse before she died.

She felt frightened. Until now she had not admitted to herself that death was a real possibility. Now it seemed almost inevitable, the ultimate in obsolescence. Her husband had tired of her, followed by her profession and her daughter. Now life itself was almost done with her.

The week dragged on, and Hannah went back to the hospital for more dialysis on Thursday morning. Her phone rang while the briefcase-sized filter was removing microbot toxins from her blood. "Mom, it's Jo. Can you take care of Morgana again?"

"Yes."

"I'll need to leave her with you an extra day. Can you take her to school on Monday?"

Hannah counted three days; her next treatment was Sunday. "My car can do it."

"OK. I can pick her up there on Monday afternoon. Thanks." She hung up as though the two women had never been at odds.

Hannah mulled over her plans while the dialysis machine finished its work. Aside from talk there wasn't much she could do for Morgana. She didn't have the energy to take the girl anywhere, and she didn't know what she should say. Even if she had all the time in the world, what words could make a child pull out of the shell she was building around herself?

Siebert came in and examined Hannah, and gave her standard reassurances. Hannah listened absently to her while the quantum computer tapped into the oncologist's instruments. Siebert left, and a few moments later a nurse wrapped up the therapy session.

Hannah went home and let the computer analyze the instrument readings. When Hannah compared them to the earlier files she realized that the doctor had lied to her. Several tumors had grown significantly in the past few days, including one next to the portal vein, which Siebert's cryptic notes suggested was life-threatening.

As Hannah read the note she suddenly understood why Siebert was so evasive. In the past few years death from cancer had become rarer and rarer, until the doctor had gratefully lost her familiarity with it . . . and her ability to face dying and high-risk patients.

It still hasn't killed me, Hannah thought.

Jo dropped off Morgana on Friday

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afternoon, and as the Porsche sped away Morgana went to the quantum computer. "I checked," Morgana said. "There's a lot of new software for quantum computers. Do you want to get some?"

"Well—let's see what they have," Hannah said. She had a vague hope of interesting the girl in something that might help her. She knew about interactive games which therapists had designed to help introverted children develop their personalities; if Morgana wouldn't try one of those, perhaps she would join a user's net and at least communicate with other machine fanatics.

In the end Morgana picked out utility software. The shopping service downloaded the software and instruction texts, and Morgana delved into it like a native diver harvesting an oyster bed for pearls. It was all Hannah could do to get her to stop for dinner. She sent the girl to bed at ten o'clock, but as she climbed into bed she thought she heard Morgana sneak into the living room to use the computer again. She was wondering if she should investigate when she fell asleep.

The house woke Hannah on Saturday morning. Still groggy, she took her medicine, then had a long, hot shower. The heat and steam revived her, and when she started to feel hungry she finished the shower, dressed, and went to the kitchen.

Morgana was already there, supervising the kitchen as it prepared breakfast. "Somebody snuck out of bed last night," Hannah said, seeing the way her eyelids drooped.

"I wasn't done," Morgana said. "Grandmaw, where's Velcro?"

"Let's sit down," Hannah said. She and Morgana carried their breakfast trays into the dining room. They put them on the table, and Hannah looked at Morgana as they sat down. "You know he was very old."

She looked down at her scrambled eggs. "You mean he's dead."

Hannah nodded.

"Are you going to die?"

"I don't know," Hannah said reluctantly. "The doctors are doing everything they can, but I could die."

"I thought that's what the stuff in the files meant."

" 'The files'?" Hannah's mind wasn't as clear as she would have liked. "You mean the medical files? In the computer?"

"Uh-huh. I read them last night. It looked bad, but I wasn't sure."

"It's bad," Hannah said. She was surprised at how indifferent Morgana seemed. Hannah reminded herself that the girl was only ten. She couldn't understand death. Hannah didn't want to think that she was already turning into the image of herself and Jo.

"I asked Mom about it, but she wouldn't tell me anything," Morgana said. "She said stuff like 'don't worry' and 'you wouldn't understand.' "

"She was just trying to protect you," Hannah said.

"She was too busy to say anything else," Morgana said. "She's always busy. Computers are never busy." The girl started eating.

On Monday Hannah was so tired she could barely get out of bed, but she forced herself to move through a shower and breakfast. She got in the car with Morgana, and rode with her to school.

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It was a long trip through the morning rush-hour traffic, and they spent the time discussing computers. Morgana talked about them the way other girls described pop stars and holo idols; to her, Hannah's quantum machine was bad beyond belief.

The phrase made Hannah smile despite herself. "Bad" had meant "good" when Jo was that age, too.

Hannah left Morgana at her school, and rested during the trip home. Her mind worked sluggishly, but she could see that her only hope of reaching Morgana was through computers. I'm not entirely obsolete, she thought. Some of the things I know are still useful . . . and I know where I went wrong with my life. I can help Morgana.

When she got home she ordered extra equipment for the quantum computer, and slept until a UPS van delivered it that afternoon. The van had the company's familiar brown-box shape, but it floated several inches above the street while the driver ran to her front door, made his delivery, and ran back to the van. The van went instantly from rest to a speed of at least thirty miles an hour. Hannah had read how that was done, but at the moment she couldn't make her mind concentrate on things like inertia fields and transition states.

She took the box of equipment into the living room and started working on the quantum computer. Some of the peripherals installed themselves, linking into the machine through low-energy microwave units, but some of the chips had to be placed inside the keyboard unit. Some were frills, such as the outsized holo projector, but at least one could prove useful. That was the encephalographic link. It was an improved, two-way version of the computer's brainwave reader, and it had cost a small fortune.

That thought made Hannah chuckle. When she had phoned in the order, the operator had suggested that she wait a few months until the price came down. Hannah would have welcomed the luxury of a few extra months. Expensive or not, it would let her continue to use the computer even if she grew too weak to work a keyboard or read a display. That would allow her to communicate with Morgana.

By the time Hannah had everything installed she had to pause to medicate herself. She felt a vague discomfort in her belly, and she took an extra pill for that. She forced herself to drink some orange juice and eat some toast, and then she went back to the living room couch.

The link proved easy to use. It sensed the electric fields generated by her central nervous system, and generated low-frequency radio waves which resonated with those fields. At first that produced only a puzzling sense of *presence*, a vague sensation she could not define. As the machine grew more familiar with her brainwave patterns it adjusted its emissions, tuning them into a closer and closer match with Hannah's mind. In less than an hour Hannah found that she could see images and hear voices in her head.

Learning to use the link proved more difficult. Calling up a menu and choosing an option demanded concentration. Hannah found herself puzzling over choices and straining to understand short sentences and phrases. She was

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trying to access the operator's hypertext when several men in orange uniforms came into the room.

She was clutching the computer with both hands. The men in orange tried to pry it out of Hannah's grip, then gave up and strapped her to a stretcher.

Hannah woke up in a bed. There was no pain, no discomfort. I must be cured, she thought. She moved her head and her eyes took in a hospital room.

"Good, you're awake," a man's voice said. "You've been unconscious all day. You're in the ICU at the Irvine Medical Center. Please do not try to move."

"OK." The rasping whisper of her voice surprised her, and speech took an effort even though she felt neither pain nor weariness. She looked around some more and saw the man. He was Otto, the computer projection. "Computer."

"Yes, I'm the hospital computer," he said in a genial voice. "I'm continually monitoring you, and you'll be happy to know that your vital signs are all stable. Your oncologist has been notified that you're awake."

The computer had misunderstood her. "No. You idiot. Want my. Laptop."

"Well, why don't we wait and see what your physician says? I'm sure Dr. Siebert . . ."

Hannah tuned him out. She realized that she did not feel good; she felt nothing. She was numb from the neck down. She was tucked into the hospital bed, and a number of tubes ran from her body to equipment on either side of the bed.

Dr. Siebert entered the room and the hologram winked out. "You gave us quite a scare," the doctor told Hannah. "One of the tumors spread to your portal vein and ruptured it. You were bleeding into your abdominal cavity. Fortunately your house called for help before anything else could go wrong."

"Still bleeding?" Hannah asked.

"No, we replaced the vein with a synthetic. Now I want you to rest."

"Wait. Want. Computer."

"Otto, she wants you."

The holographic doctor reappeared. "No, Dr. Siebert. When she was admitted she had a portable computer. She asked for it."

"Want it."

"You're in no shape to use it," Siebert said.

"Just put. It on. Nightstand."

"It's in the closet with her clothing," Otto said. "It seems to mean a great deal to her."

"I can see that, Otto." Siebert went to the closet and put the keyboard on the stand next to Hannah's bed. "Here it is, Ms. Ruscomb, but you're much too weak to use—"

"Just want. To see. It there."

"Very well. Please rest now."

"Tell me. My condition."

"You've had a minor setback, but we have everything under control," Siebert said. "We'll continue treating you as before." She left.

A minor setback, Hannah thought sourly. She was obviously on total life support, which meant her body was failing fast. She felt an odd sensation around her throat, which suggested a neurocollar. Hannah guessed that she would have been in agony if the loop hadn't been there to block out all sensation below her neck.

She closed her eyes and thought com-

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puter commands. To her relief the quantum computer's link responded. She accessed the hospital computers and found her files. The code-breaking work her house had done made it easy to read the data. The link gave her a holographic view of her insides; she found a liver riddled by carcinomas, and several new tumors which had appeared throughout her body.

This was more than a setback, she thought. She found a tutorial database in the network and followed its hypertext links for data on cancer. The tutorial was designed to help instruct medical students, and Hannah fed the computer instructor all the data she found in her file. After a moment it presented her with its prognosis: death in twelve to thirty-six hours. A grading subroutine congratulated Hannah on the accuracy and completeness of her data.

The finality of the prognosis frightened her. A day and a half at most, and that would be it.

"You're upset." The voice of the holographic doctor spoke at her side. "Shall I call a nurse? A tranquilizer—"

"No. I'm. Fine." She didn't want to be left doped-up and helpless while the end came. She'd rather be scared.

She needed a way to take her mind off the fear. She got on the computer again, linked into the hospital network and searched its databases. Hannah followed every hypertext link she found on new cancer treatments, but in the end she was forced to admit defeat. Nobody had developed a miracle in the past few days.

Yet there might be a way out. Hannah recalled Jane Townsend's quantum doors, Zalinsky's paper on Planck states, and reading about a quantum-tech approach to spotting cancerous cells. Suppose they could be combined: spot the tumors and raise them to a higher Planck state. That would remove them from her body, at least temporarily. Return them to the ground state—reality—one at a time. The microbots could handle them one after another.

It might even work, Hannah thought. The equipment she would need already existed. All she had to do ("all"—she smiled sardonically at the qualifier; a nurse working the evening shift looked at her and thought she was smiling in her sleep) was locate the appropriate equipment, learn their specifications, find a way to link and control them, then actually bring them together and try them. The mechanical work itself would be easy—find the equipment and patch them into a computer—but the design and programming could take weeks or months. Too bad she didn't have more time. If only her mind could work as fast as a computer—

Well, why not? she wondered. She was ready to clutch straws. A personality simulator could operate at cybernetic speeds, and if the simulated personality was hers. . . .

Creating a simulated personality was not an especially difficult task, although it would have to be a highly detailed simulation. A simple one, such as Otto or the one in her house, could never handle a task this sophisticated. Hannah activated the computer's modem and located the best personality-simulator software she could find. The software she found was data-hungry; when she ran it, it demanded a full encephalogram

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and a detailed brain scan.

The hospital files had a CAT scan on file, and the quantum computer's link could supply all the brainwave readings the software required. Hannah fed the data to the personality software, and let it execute in the quantum computer.

<<Error message #38: Program too large for RAM space.>>

Hannah swore bitterly as the message echoed inside her head. She accessed the hospital's computer, but when she tried to load in the software the machine unceremoniously booted her out. Hacking into files was one thing, but running a major, unauthorized program was another matter.

Use her home computer? No. It would take a full day to download all the data through the bottleneck of the modem. She needed to find another computer. She could buy one, she thought, but now the usual overnight delivery would take too long.

There was another possibility. She'd read about the possibility of constructing computer circuits out of photons alone. She had spent an afternoon studying the theory behind it. It was worth a try; what did she have to lose?

The theory was simple, and the only tools required were a quantum computer and the appropriate software. Hannah found the software. It was not meant to generate a structure as complicated as a computer's circuitry . . . but there were programs which were specifically written for that task. Hannah found one which was compatible with the quantum software. She turned it into a subroutine of the quantum software and let it run.

<<Batch job successfully completed.>>

The speed with which the software did its work pleased Hannah. It seemed a good omen—if it had done everything as well as she hoped it had. The quantum computer assured her that it had; its diagnostic messages claimed that it was now linked to a computer far more powerful than itself. Hannah loaded the personality software into the photonic computer, and waited nervously for an error message.

<<Program ready. Proceed?>>

Hannah told the machine to go ahead, and it responded by asking for the CAT scan data. While it churned through that data, a chatty subroutine told Hannah that it was configuring the computer circuitry to match her brain's physical structure. The photonic computer operated swiftly, and it interrupted the subroutine before it could finish its lecture. The machine now asked for the encephalographic readings.

Hannah fed in the EEG's output. The software told Hannah that this phase would take at least half an hour, while the computer analyzed the electrical dynamics of her brain.

Hannah fumed at the loss of precious time. Was anything really happening? She had seen this happen before with computers: garbage in, nothing out. The computer could lock up over some minor hitch, misread data through some idiotic oversight—anything. Hannah wished that Morgana was here; her granddaughter could have helped her keep things straight. For all her youth and problems the girl had a superb mind.

Memories of Morgana gave her pause. Hannah realized that she did not fear death itself; she feared the loss of

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life. She would not be able to keep Morgana from growing up like herself: self-centered and oblivious to the people around her, ending up alone in a hospital and filled with regrets, with her life over and no time to correct her mistakes—

Hannah chopped off that line of thought. Getting maudlin now would help neither Morgana nor herself. Hannah ordered herself to take notes. That would keep her focused on the work, and it might help her spot whatever errors she had made. Using the quantum computer's desk utilities, she opened a file and began making entries.

She was recording the modifications she had made to the software when she felt an odd sensation of movement. The ICU seemed filled with light, and then Hannah felt she was rushing through a darkened tunnel toward a brighter light. People waited in there to greet her.

Not now, she thought, I'm busy. After a moment, or an eternity, the light and people faded away. Hannah resumed taking notes. When she had finished she tried to access the personality simulator in the new computer, to program it with its research project.

Nothing happened. Annoyed, Hannah checked the photonic computer's memory registers.

She seemed to be in them.

There was an embarrassed pause while Hannah recalled that the near-death experience—a hallucination caused when the dying brain flooded itself with ketamines—was often described as involving bright lights, movement through a dark tunnel, and crowds of old friends. You're really oblivious, she told herself, when you don't even notice you've died.

Hannah poked through the computer system, and found that the photonic computer—or herself—was still linked to the quantum computer. Vision returned when she accessed a monitor in the ICU. The crude black-and-white video camera showed a medical team trying to revive her. She found their actions moving. They didn't know her, but they were straining to save her.

She wondered what she was—Hannah Ruscomb, or a personality simulator that thought it was her—or did the question have any meaning? Perhaps it was like asking if you were the same person you were yesterday. She'd heard that question in . . . in . . . she had heard it *somewhere*, from somebody, but she couldn't recall the specifics.

Brad, she thought. Perhaps he had mentioned it. After all, her ex-husband had been a—something to do with colleges and teaching, she thought. She couldn't remember.

For a moment Hannah thought her memory was fading away. Then she recalled how she had come to be in this state. The brain stores short-term memories in the form of electric fields, and it was those which the computer had duplicated. Long-term, permanent memories are recorded by RNA in chemical form, and the personality software could not access that.

She had lost much, and now it was impossible to retrieve the memories in her old body. Yet she retained enough to keep her sense of identity, and perhaps that was the important thing. In this form she was probably immortal, and she might have all eternity to make new memories.

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Yet something was wrong. The photonic lattice was unraveling, slowly degrading her ability to think. She needed something to replace the missing photons . . . a power source.

She had none, and she could think of no way to draw energy from the quantum computer or any other source. She could do nothing to stop the shrinkage. Thought is work, and work requires energy; each thought she had consumed a little more of her substance. She remained as mortal as ever.

Hannah felt wistful. I didn't beat death, she consoled herself, but I gave the bony old boy a fight. Her one regret was that she would not be around to help Morgana.

Yet perhaps there was one last thing she could do for the girl. Hannah found the notes she had been making when she died, and added a few comments to them, detailing the problems that were destroying her. They could be overcome, and when they were Morgana—and the human race—could achieve immortality. She created another file, a codicil to her will, giving all of her computer equipment and files to Morgana. In time the girl would understand what Hannah had done here.

As Hannah faded away she felt at peace with herself. She had not been obsolete. She had given her granddaughter the gift of immortality. It might take the girl a century to overcome the problems she had, or a million years—but she would have those years, and more. ■

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THE REFERENCE LIBRARY Tom Easton

Exile, Michael P. Kube-McDowell, Ace, $17.95, 289 pp. (ISBN:0-441-22211-0).
Flying Dutch, Tom Holt, St. Martin's, $18.95, 252 pp. (ISBN:0-312-06975-8).
Transcendence, Charles Sheffield, Ballantine/Del Rey, $18.00, 275 pp. (ISBN:0-345-36981-5).
Bright Angel, John Blair, Ballantine/Del Rey, $3.99, 291 pp. (ISBN:0-345-37058-9).
Beachhead, Jack Williamson, TOR, $18.95, 368 pp. (ISBN:0-312-85154-5).
Chanur's Legacy, C. J. Cherryh, DAW, $20, 386 pp. (ISBN:0-88677-519-1).
Books on Disk

According to Michael P. Kube-McDowell, the city of Ana is a strange place, growing into a desert world in concentric rings from an ancient core, dominated by a high arch containing thirteen bells that ring when the ground shakes. Its people share responsibilities in the production and repair of what their society uses. They also strive for an equitable sharing of food, clothing, and other goods, while their government issues orders and proclamations through household radios. Their own fertility is a crucial concern, and women choose their mates from those men who run the streets to show off their prowess.

The reader's initial reaction may be that Kube-McDowell's **Exile** bears some resemblance to Orson Scott Card's *Memory of Earth.* But that resemblance is soon lost. Kube-McDowell is not rewriting the Pentateuch. He is...

In some ways, Ana seems a model of a communist society. It has an oriental feel. And in due time, these features snap *Exile* into as tight a focus, a focus all its own, as anyone could wish.

The tale begins with the introduction of Meer Faschen, a minor functionary of Ana. He is visited by a man from outside the city —where, it is said, nothing can survive—with a message: A long-gone

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friend of Meer's, Kedar Nanchen, is on the verge of death and wishes, once dead, to return from exile, his remains to be accepted back into the city's ecosystem. Meer, as it happens, played a part in his friend's exile. He feels himself a traitor, and as he agonizes over whether to ignore the message and maintain his comfortable life or to acknowledge the debt of honor he owes. He begins to recall those days when he was young, when he met Kedar the teacher, the councillor, the intellectual who questioned the conventional wisdom of Ana and led his students into effervescent protest, with Meer the worker trotting along behind, all excitement and fascination and heigh-ho for truth and freedom. Now Kedar's name is never spoken. The events that led to his exile officially never happened. No one admits to remembering.

The ferment was at its height when a new star appeared in the sky and the city's household radios spoke in a strange voice that claimed to come from the star and greeted the people of Ana as long-lost kin. There is no mystery here for the SF reader. Ana is clearly a colony, the star a ship from home. But to Ana's people the mystery was profound. And when the city's chief proclaimed the star's message a delusion, a snare, a conspiracy of sedition, the students of Kedar's camp erupted. They occupied a broad square in the city, and . . .

Here is that snapping into focus I mentioned. Think Tienanmen Square in Beijing, and you know instantly what to expect: slaughter, repression, exile. Yet this was in the past. Now we have Meer Faschen, a man in a quandary, a man in the throes of forbidden memories, a man who must accept the commission of conscience.

What does he find when he treks forth into the wilderness? Memory, in the guise of a cliff festooned with desiccated exiles. Memory, in the guise of a community of living exiles where no life is supposed to be possible. Memory, in the guise of a living—though near death—Kedar Nanchen. Knowledge, as when he realizes that "He would not be able to escape the knowledge that he had chosen silence—that he had endorsed that which, until then, he had only accepted by repeating to himself that he was helpless to change it." Faith, as when he sees that "somewhere beyond the darkness, there was light."

And finally the silenced truth returns to Ana.

Exile's end is perhaps too easy, but its point is essential: Evil rules most easily when good people close their eyes and mouths and take the easy road. Nor does *Exile* forfeit any strength for that point by being an allegory of recent history.

I admire Tom Holt's work tremendously, and I said so when I reviewed his *Who's Afraid of Beowulf* and *Expecting Someone Taller*. Now I can say so again, for St. Martin's Press recently sent me Holt's latest, ***Flying Dutch***.

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If you read the earlier books, you know that Holt likes to bring the legendary past into the present, stand back, and watch the fun. More precisely, he likes to bring that portion of legend that has also entered literature into the present, as when he brought Wagner's *Ring* to life for the *Taller* book. This time it's the legend of the *Flying Dutchman*, which was also handled by Wagner.

The premise is straightforward enough: Back in the 1580s, merchant captain Cornelius Vanderdecker gave an alchemist named Montalban a ride from Spain to England. On the way, the ship ran out of booze and the crew raided Montalban's luggage for a jug of what looked like rum. Unfortunately, the "rum" was the elixir of life. Vanderdecker et al. were now immortal. Equally unfortunately, the elixir had a notable side-effect: a body odor so colossal that ever after, except for one binging month every seven years, no one in the world would permit Vanderdecker on land.

Fortunately, Montalban had a swig too, and he has been struggling ever since to find an antidote, or at least a deodorant. In the process, he has been responsible for the rise of modern science and technology, though he has generally let others take the credit. He has also come to own much of the world, what with compound interest and all that.

Or has he? At one point in his career, Vanderdecker bought a trick life insurance policy. The trick was that the insurance underwriter, aware that precious few sailors died of old age, had promised to increase by 50 percent (compounded, of course) the payout for every year the policy holder lived past 75. If Vanderdecker ever *does* die.... Enter Jane Doland, a young accountant who has not been properly worshipful of a male colleague and has then made the mistake of stumbling upon the world's best-kept secret: The Vanderdecker Policy. "Please," ask her bosses. "Would you find Mr. Vanderdecker and offer him anything, *anything*, to let the world off the hook?"

She succeeds, largely because she has a very poor sense of smell but also because Montalban's researches now involve the nuclear reactor at Dounreay, Scotland. And then... the logic of the situation hangs together only up to a point. But that is as it should be with any humor that owes a recognizable debt to P. G. Wodehouse.

As for the outcome, I invite you to consider the advantages of being indestructibly immortal when it comes to tackling a runaway nuclear reactor, and the purifying effects of a nuclear explosion.

And by the by, according to Holt, Wagner learned the story from Vanderdecker himself. In a bar, over drinks, which probably explains why Wagner didn't get it straight.

Charles Sheffield's **Transcendence**, Book Three of his "Heritage

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Universe" series, is the sequel to *Summertide* and *Divergence*. Humans have gone to the stars, there to find other sentients and a number of enigmatic structures, artifacts of the Builders who vanished millions of years ago. In the first volume, the quest for understanding and loot led Darya Lang, scholar, Hans Rebka, troubleshooter, Julius Graves, member of the governing Council, Louis Nenda and the Cecropian Atvar H'sial, unscrupulous treasure-hunters, and J'merlia and Kallik, Louis's and Atvar's alien slaves, to a new Builder artifact. The second book hurled Our Heroes to a vast, far-distant space station where a still-functioning Builder robot introduced the same characters to a group of Zardalu land-squids—abhorrent, ruthless, one-time lords of the galaxy, believed extinct, exterminated in the Great Rising.

Now Sheffield tells us that the Zardalu escaped to their original home world, there to use their colossal breeding powers to restore their numbers and power. The civilized galaxy faces a threat it has not known for many millennia. It must be warned. Unfortunately, the scholars and bureaucrats of the time laugh the threat off. The Zardalu are extinct. It says so, right *here* in the data base.

Our Heroes must therefore go ahunting once more. Fortunately, the location of the long-lost Zardalu homeworld yields at once to their keen intellects, and they soon discover another Builder mystery. The world they seek is embedded in a region of space where quantum effects go macro and another robot makes sure that no one leaves. The Zardalu are there, and their numbers are already much greater. They still shrug off all sorts of physical attacks, but now they seem less imposing than they did in *Divergence*, when they literally ripped people limb from limb. Indeed, they seem strangely reluctant to get rough this time around, and Our Heroes—though they worry a lot—survive easily. Most of them even escape, and this time they have the bit of evidence needed to convince the galaxy of its danger.

Most of them escape. Two don't, and their final confrontation with the indomitable monsters seems to be setting up the fourth and last volume of the series, *Convergence*, when the Builders return.

I didn't enjoy this one as much as I did the first and second entries in the series. Sheffield's wonders are no longer fresh, and the conventionality of his plot structure and casting show through far too plainly. Nor does it help to see such mighty villains as the Zardalu falling down like dominoes before the clever, resilient, slippery, freedom-loving humans and their allies. Human supremacy is one of the all-time favorite SF myths, but it has become an annoying cliche. It's annoying because there is no justification for it other than whistling-past-the-cemetery braggadocio. If we ever meet the boogeyman for real, the truth may well be some-

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thing else again—and we can say that without getting into the equally annoying cliches of horror fiction.

Ah, well. It's still good old-fashioned sensawunda adventure. I'd have drooled all over it when I was fifteen, before I turned into a critical nitpicker.

And if you need another reason to buy the book, the dedication will show you what a statistician considers worth a snicker and a wink.

Between the cover blurbs and the first few pages, it doesn't take long to grasp the gist of John Blair's **Bright Angel**: In the middle of the twenty-first century, after the world has survived a number of political and ecological catastrophes, humanity has shipped a colony to Comfort, a planet of the star 61 Cygni B that a robot probe has tagged idyllic. Unfortunately, when the colonists got there they found a frozen hell and no way home. Colonist James Harris (wearing snowshoes of elkhide and don't ask where the elk came from), nearly frozen to death, prays for deliverance and ★PRESTO★ he's in Antarctica. How? No one—least of all Harris—knows. The mystery is shelved. But then the Earth shows strong signs of slipping into an ice age of its own, Harris seems to have discovered a link to a being he calls an Angel, the global cooling seems to have begun when he came home, and a Chinese technician scanning records discovers that an alien spaceship appeared in the very hour of Harris's return and is now leaving the Solar System. It's all his fault. Something or someone killed Comfort, and he brought it back. Now it's killing Earth.

What is it? No one has a clue, though the Chinese think it worth trying to kidnap Harris for intensive interrogation. When that fails, a Chinese general and would-be tyrant decides to steal the just-completed colony ship waiting to leave for Vega and chase down the alien boat, thinking it must contain some stupendous technological secrets. Fortunately, the good guys have the same agenda and are one very short hop ahead of the ninja pirates.

I won't tell you the answers Blair provides. They'll do in the sense that they explain what needs explaining and provide a suitable ending for the story. Blair also does a pretty decent job of getting the technical bits right, or near enough, although he is less good at making these bits seem an integral part of his world—the feeling is something like biting into a whole wheat roll and, b'golly, here's a raisin. It's fine, thanks, but what's it doing here?

The way he handles character bothered me more. New ones keep popping up with very little preparation of the ground, as if he is playing Lego with plot-extension blocks. And the details that explain why characters are who they are and why they do what they do are added on only much later, as if Blair remembered too late that he needed to do a bit of "characterization."

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The overall feel is thus more than a little bit impromptu, awkward, and afterthoughtish. And that's too bad, for it's a problem that could surely have been fixed by doing one more draft. Lacking such a fix, Blair's story is readable and entertaining but not as much so as it should have been.

Jack Williamson's latest is the sort of old-fashioned SF we all remember fondly. There's a rich-boy hero, Sam Houston Kelligan, and the army son of his father's mistress, Marty, who may or may not be Sam's half-brother. There's the girl Sam left behind, LeeAnn, childhood sweetheart whom he loves less than he loves Mars. There's Sam's crewmate Jayne, lovely, born poor, mistreated by Marty, hating wealth and Kelligans. There's a mysterious disease escaped from Martian samples retrieved by robot missions. There's an international consortium, the Mars Authority, holding together just long enough to launch Sam and his crewmates to Mars, leaving the follow-on ship still in pieces. There's a landing on the Red Planet, a crash, survival under desperate circumstances, fear of plague, betrayal by a woman crazed with the lust for fame and fortune, loss of the main ship and its invaluable cargo. Marty picks up the pieces of the collapsed Mars Authority and builds a new outfit, Mars ConQuest, that sells shares to the public, promises the terraforming of a desert world, lebensraum, and wealth, and leaves the second Mars ship still in pieces, the explorers marooned and doomed in the name of greed. And every time Marty steps on stage, his stickpin wears a bigger diamond, while Sam's mother wails and wrings her hands and LeeAnn's belly swells.

But wait! The only reason the explorers' landing craft cannot return to Earth is the small amount of reaction mass it can carry for its fusion drive. If the explorers can haul Martian water into space and fill giant baggies that craft can tow, one man just might be able to make it home to tell the truth and bring rescue.

Beachhead has derring-do enough for anyone. High adventure and low, low villainy. Romance and pluck and grit. The stuff of Saturday matinee serials and the dreams of young readers just discovering the headiness of the imagined future.

Unfortunately, it all feels rather old-fashioned and unlikely to jaded long-time readers. It's as if the world had not moved past the 1940s, say, and villains of commerce could still scheme to their heart's content with no risk of being stopped by nosy regulators or intrepid journalists. (And yes, I know, scandal still happens. But it seems to be a little subtler than what Williamson offers here.) If that doesn't bother you, enjoy. If it does, find something more complex and realistic.

Remember C. J. Cherryh's *Pride of Chanur* and its sequels? A single forlorn human had fallen into the midst of a complex multispecies,

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interstellar civilization beset by interspecies rivalries, and Cherryh showed it all from the viewpoint of the catlike hani, represented by Pyanfar Chanur, captain of the *Pride*, and her crew of interstellar traders. By the end of the fourth book, Pyanfar was the head of the whole shebang known as Compact Space, stepping aside to pull strings from off-stage and maintaining the peace.

Did you wish for more? If so, Cherryh has finally chosen to oblige you with **Chanur's Legacy,** number five in the series. Hilfy Chanur, once a member of Pyanfar's crew, is now the head of the Chanur clan and captain of the *Legacy*. As was her aunt (at least ostensibly), she is a trader, and when she arrives at Meetpoint station she is quite interested in the deal offered by the station's stsho governor, No'shto-shtistlen: deliver this ceremonial trinket, this "Preciousness," to another stsho at Urtur. The fee? A tempting million. Hilfy of course consents, and only then does the governor hand her the massive contract with all its enormous potential for interspecies misunderstanding and draconian penalties for nonperformance. Only *then* does the governor add the minor request that she also take off his hands Hallan Meras, a hani abandoned by his ship after a spot of roughness. Hallan is young, handsome, and male, trouble on three counts, not least because male hani have a reputation for irrational violence. He is also poorly trained in ship's procedures and quite well intentioned, which in due time leads to expensive trouble.

And they're off, only to find the scheming mahendo'sat prying at the nature of the Preciousness, the predatory kif taking an interest, the five-brained t'ca watching and interjecting cryptic comments. When they reach Urtur their addressee is gone to Kita Point. They follow, and the stsho has fled once more, aided by kif, leaving just one panicked stsho behind to beg for rescue. They follow once more, to find flight again and this time dead stsho left behind. There is a hint that the Preciousness is a classic white elephant, a stone of obligation to hang about the recipient's neck. There is a hint that it represents what passes for stsho romance. Signs accumulate that the *Legacy*'s mission reflects some upheaval in the mahendo'sat and stsho civilizations, some struggle for advantage and dominance, while the kif, though they are given to self-interest and treachery, may actually be serving Compact Space. Indeed, Aunt Pyanfar may be watching unseen, intently interested in what is happening but keeping her meddling claws out of the stew. Meanwhile, the game of male and female is playing itself out aboard the *Legacy*, the conservative bureaucrats of Anuurn, the hani homeworld, are preparing once more to punish Chanur presumption; Chanur foes are filing charges of kidnapping and rape over Hallan's presence on the ship; the stsho custodian of the Preciousness is finding romance with the Kita Point refugee.

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Cherryh's tale has a straightforward core made complex by tangled motivations, political uncertainties, varied alien psychologies, and intercultural misunderstandings. The result feels frantic, confused, bewildering—much like real life—but it also feels remarkably convincing. Cherryh has a gift for bringing her imagined worlds to life. She also fulfills her responsibility as an author: In due time, the smoke clears and both Hilfy and the reader enjoy the satisfaction of knowing what everything was all about all along. Although Cherryh does leave enough ambiguity to permit another sequel or two.

BOOKS ON DISK

Disk-top publishing keeps on trucking. The eighth issue of the *Electronic Publishing Forum* just came my way from John Galuszka's Serendipity Systems (P. O. Box 140, San Simeon, CA 93452) with word that *Analog* readers can have all eight issues for a mere $12.50 (compressed into five 360K MS-DOS disks containing the equivalent of nine).

This issue includes information on the latest "Ruby's Pearls," tells you who's who in electronic publishing, and more. Included is a set of programs from John Napier's Another Company (P.O. Box 298, Applegate, OR 97530, 503-846-7884). One allows users to build small databases quite easily (though it takes up a lot more memory and disk space than Dean Lambe's tiny MYSTUFF miniprograms; contact Wily Wetware Ltd., 3403 Murdoch Avenue, Suite 119, Parkersburg, WV 26101, for information). Another turns sense into nonsense. The best makes it about as easy as it can get to prepare your own disk-top package.

Something I'm looking forward to seeing is Serendipity's "Hypertext Hamlet," using Ted Husted's DART interface. It's hardly SF, but making the definitions of Elizabethan words and all the footnotes instantly available—sounds like a great way to demonstrate the technology.

And, oh, yes—The Disktop Publishing Association has inaugurated the Digital Quill Awards for excellence in disk-top publishing. This is a crucial step in improving the quality of what's available on disk. Since I've used some space here to bemoan that quality, it surely serves me right that I have been invited—and have agreed—to be a judge. In due time I'll tell you who the winners were.

Perhaps the best sign that disk-topping is going to make it big is that—according to *Time*—Apple is bringing Modern Library titles such as *The Sound and the Fury* and *Moby Dick* out on disk for its PowerBook computer. In addition, Arizona's Slate Corporation has a device with a touch-sensitive screen that lets a user flip pages with a special stylus, and Florida's Booklink is promising a notebook-size gadget that loads books from a coin-op dispenser.

The effort's there, and the level of activity seems to be growing. I'll keep watching. ■

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BRASS TACKS

Dear Stan,

Let me preface this, my first letter to the editor of *Analog,* with some pertinent background facts. First, I have been a subscriber to the magazine since about 1945, and it continues to be one of the highlights of my month. Second, my political stance is somewhere between ultra-conservative and libertarian, and, perhaps somewhat surprisingly, it has not changed. This means that, while being extremely conservative on economic and most social issues, I am an atheist believing that religion is one of the worst forces for evil in the world; I am fervently pro-choice in both abortion and in the education area; I am opposed to racial discrimination but equally opposed to "affirmative action." I am for the individual's and private associations' right to discriminate in any way and on any basis they desire; and I think it is fine to burn a flag if you have bought and paid for it yourself, but not if it is somebody else's flag.

As you can well imagine, I have spent most of my life as an outsider, belonging nowhere, ideologically speaking. In John W. Campbell I found the nearest thing to a kindred spirit. He was my idol, in a way, until his death. His untimely demise upset me more than any in my lifetime except, perhaps, that of Anwar Sadat. Well, Stanley, you have been the nearest thing to a clone of old JWC that I could possibly imagine. Your editorials even have the same *tone* as his. You have even avoided some of the pitfalls he fell into, *viz* the Dianetics fiasco, and the Heironymous machine nonsense. I was not pleased with the editorship of the magazine during the interregnum between the two of you.

The reason for my fascination with JWC, and with yourself, has to do with the fact that you have the courage to gainsay so many of the things that "everybody believes," and to puncture so many popular balloons. This means that you have never supported any of the now totally discredited socialist ideas that nevertheless a majority of our political figures still espouse.

Now to the real reason for this letter. Your April 1992 issue contains a novelette called "Green Fuse," by Stephen L. Burns. The author obviously has such an outrageously left-wing axe to grind that I found it so disgusting and offensive that I literally could not read it.

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Rarely have I been so angered by a piece in your magazine. A few more of these and I might just cancel my subscription. Although I know that one subscription means little to you, I think this would be a shame, especially for me. Now, in general, I approve of your editorial policies, everything from pure space opera to sophisticated extrapolation of present social and political trends being properly comprised within the definition of "science fiction." I thank you for not succumbing to the temptation to include such nonsense as "sword and sorcery," "magic," and in general "supernatural" and "fantasy" themes. However, I do have one pet peeve, as exemplified in the novelette, "On the High Frontier," by Michael F. Flynn. It is, namely, the story written in the first person in the cutesy "folksy" style. This, to me, is a real turnoff, although I would have held my peace had not it been in the same issue as the other story. I just wanted you to know that this particular issue was practically unreadable to me.

FRANK B. HARRIS, JR.
Portola Valley, CA

I'm sorry you didn't like "Green Fuse" or "On the High Frontier." However, just as you were disturbed by those stories, I found it a little disconcerting that you would consider cancelling your subscription because of one story, or even a few, that rubbed you the wrong ideological way. No doubt much of what I choose to publish shows the influence of my tastes and attitudes, but I don't demand that every story conform to my personal ideology. (Neither did Campbell; a hallmark of Analog *has long been a willingness to air a wide range of viewpoints.) I bought "Green Fuse" for the very simple reason that I found it a very* entertaining *story.*

I'm sorry you didn't, but please consider this: in trying to entertain 100,000 highly individual people at once, it would be truly astounding if any of them liked everything *we publish, or if all of them liked anything!*

Dear Dr. Schmidt:

Finally, after all these years, a factual error I can confidently point out without fear of scientific contradiction!

In Michael F. Flynn's entertaining "On the High Frontier," a bad guy is eliminated when "... the stranger's bolo wrapped itself around his neck." This is quite a feat for an object that my dictionary defines as "A large single-edged knife used by natives of the Philippines."

As a jeweler, I custom-make Western string ties of the sort favored by the good Dr. Asimov and, currently, in more *avant garde* styles, by many fashion-conscious women. They are almost invariably referred to as "bolo" ties, which is incorrect.

The weapon used in Mr. Flynn's tale—and the inspiration for the ties I make—is the bola, a South American throwing device, consisting of weighted balls fastened to cords. It is used for catching cattle and in hunting.

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Otherwise, the story was great. And I realize there's about as much chance of restoring the word "bola" to its rightful usage as there is of making people realize that "media" is the *plural* of "medium." Or how about that singular character from "Star Trek: the Next Generation" who should be named "Datum?" Ah, well.

RICHARD O. MARTIN

Shell Beach, CA

Dear *Analog*,

I would like to add to the information presented in "Cyberspaced Out: Manners and Mores in the Global Village," by Rick Cook & Pete Manly (April '92).

First, I would like to say that the article was quite well done and presented a good overview of the developing telecommunications society. I found most of their observations consistent with my own experiences on BIX, the Internet, America Online and local BBSs.

However, some of the information they gave regarding the Usenet doesn't give the whole picture. The Usenet is actually a conference substructure of an entity known as the Internet. The Internet is the international "backbone" connecting numerous single sites & wide-area networks such as Alternet, EUnet, NSFnet, NEARnet, JVNCnet, etc. In fact, the DASnet mail on BIX mentioned in the article is actually routed throughout the Internet. These networks include educational, military, government & corporate machines. There are also "Public Access Unix" hosts which allow the user to connect for a fee and read the "newsgroups" of Usenet and send electronic mail.

Also, while it is true that the vast majority of the 3000+ Usenet newsgroups are unmoderated, a significant portion are moderated by a designated user. The moderated newsgroups tend to be the more technical ones, such as the comp.xxxx and sci.xxxx hierarchies.

There are several newsreader programs available to our users, most of which allow them to preview the subject line of each post. This allows the user to act as his own moderator/censor, as well as giving the ability to follow only those posting threads that interest them. If a certain subject continually crops up that the user isn't interested in he can use various means to avoid even being aware that they exist. The authors alluded to a "twit bit," but there are others, such as Kill files used by the program RN (readnews). Kill files and the like are most useful in the alt.xxxx and rec.xxxx hierarchies where signal-to-noise can get very bad sometimes.

Of all the networks and such I've frequented, I find the Internet to be the most stimulating and full of the potential the article talks about. True, it can be anarchistic but it can also be a vast resource of information and entertainment.

KEVIN S. GREEN

Brighton, MA

Dear *Analog:*

Frank Kelly Freas's article, "The Story Between the Words," brings up a question or two.

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Freas says more illustrators are needed, states the criteria, and then—other than entering the L. Ron Hubbard Illustrators of the Future contest—gives no other way to break into illustrating science fiction. I am not an artist and never will be, but know a talented person interested in illustrating and writing science fiction. Writers have an alternative: They can submit to various publications. Can illustrators?

Hubbard's Scientologists have a bad reputation as a cult and future illustrators are refusing to participate in a contest sponsored by this organization. Frank Kelly Freas is a judge in this contest. Is he a Scientologist? Is there danger of being pressured or brainwashed if one enters these contests (illustrators and writers)? I would like to know. I am sure any future illustrators out there would also like to know of other ways to break into science fiction.

MRS. NORMA LOVEJOY
Chewelah, WA

The author replies . . .

I am sorry that I seemed to imply that winning the contest is the *only way* to break into the business; I definitely did not *say* so in the article. There certainly are other ways, most of which involve a considerable expenditure in shoe leather or postage. Winning the contest does not solve the problem, but it certainly can help.

Not only may illustrators submit to various publications, it is typically how illustrators market themselves. One criterion that helps new illustrators to get *noticed* by art directors is the presence of published pieces in their portfolios. Certainly unpublished pieces get attention, but it can help some art directors in deciding whether or not to take a risk on a new talent if it has been demonstrated that *other* publications found value in his/her work.

In addition to receiving cash prizes, winners in the L. Ron Hubbard Illustrators of the Future Contest can illustrate a story in an upcoming volume of *Writers of the Future*. Winners sell first publication rights for which they are paid a rate commensurate with the standard in the industry. They keep their original artwork and all other subsequent reproduction rights. They also have a terrific piece of published work to show in their portfolios, and receive all the promotion they can tolerate.

I cannot agree with your opinion that "future illustrators are refusing to participate in a contest sponsored by this [L. Ron Hubbard's] organization." In my experience, of the many talented amateur artists I come into contact with at the many science fiction conventions a year I attend, 9 out of 12 of them would rather continue to "do their own thing" than become "*mere illustrators*."

L. Ron Hubbard has been highly productive in a number of areas, Scientology being, perhaps, the best known by some. Among his other writings (manuals on business management, the arts, health, etc.) was his prolific output of pulp and science fiction. In the so-called Golden Age of SF, Hubbard remembered how, through illustration, the characters and their drama came alive picto-

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rially as well as in prose, forming a strong symbiotic relationship between writer and artist. This creative synergy, he felt, was in danger of becoming lost. The illustrators contest was founded as a philanthropic endeavor to ensure that the relationships between the written word and the illustrator's art would not die.

Before his death in 1986, L. Ron Hubbard designed the "Writers and Illustrators of the Future" contest to encourage novice writers and artists. The now separate contests are sponsored by Author Services, Inc., the literary agency which promotes the fiction of L. Ron Hubbard.

In answer to your other question: No, I am not a Scientologist. Contestants are not exposed to Scientology. It is not mentioned in the rules, the art specification instructions, nor in my letter of congratulations to the winners. Being a Scientologist was not requisite to my having been asked to be coordinating judge of the Illustrators of the Future Contest. I accepted the position, and hand-selected as judges fifteen of the finest illustrators of my acquaintance, for two reasons: (1) because I believe in the value of the contest, and (2) to pay back to some degree the field that has kept me and my family eating regularly for forty years.

From the time of its original announcement, the Illustrators Contest took well over a year to get off the ground. That time was spent in Author Services' legal department to ensure that each entrant had all of his/her rights protected. I can assure you that I would not have sacrificed so large a part of my life to this contest, to the serious reduction of my illustration business, nor would I have staked my name and reputation thereon, if I did not truly believe in the great and continuing benefits to be gained through the contest.

FRANK KELLY FREAS

Dear Dr. Schmidt:

I couldn't agree more with your editorial (April, "E Pluribus Zero") about the use of the English language as the essential element in "melting pot—USA." I am a professional interpreter-translator of Spanish, and would stand to benefit if Spanish became our alternate language. But I lived several years in Canada and saw the extremes to which bilingualism can be taken. No government document could be issued until it had been translated into the other official language, even in the western provinces where almost no one speaks French. There was a tremendous translation backlog, and this caused delays in letting people know the laws and regulations governing them.

J. EDGAR WILK

Carrboro, NC

Dear Mr. Schmidt,

I was surprised that your editorial in the April issue showed you had not bothered to examine your assumptions. Here is some information that may be helpful to you next time you are confronted with this issue.

First of all, wholesale distribution of Puerto Rican pamphlets to mainland Hispanics will not solve the problem of delivering Medicare information to all Spanish-speaking

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Americans. You must not be aware that there are different varieties of Spanish just as there are of English.

On the whole issue of bilingualism, though, your position is typically uninformed. Public schools in New England were taught in Swedish in prerevolutionary war days. My Wisconsin-born father informed me that until the 1920s or '30s, public schools in his state were likely to be taught in Polish, Czechoslovakian, or German. Yes, Mr. Schmidt, German.

I am having a problem with this matter. With the long history of bilingualism in this country, why is the issue suddenly threatening when the language in question is Spanish? I have memory of Lawrence Welk's accent causing laughter, but recall no tirades against the use of German in public schools. Why do so many people feel threatened by a lyrical language which is, incidentally, used by most of the inhabitants of this hemisphere?

You made several comments about "adopted citizens" who either will not or cannot learn the language of their new country. I agree with you here. Be aware however, in large parts of this country Spanish *was* the original language; we moved (dare I say immigrated?) in on them.

Salud, Sr. Schmidt, y pesetas y amor. Y el tiempo para gozarles.

KAY C. SAUNDERS
2119 West Hickory #1
Denton, Tejas 76201

I am very aware of regional variations in Spanish. I'm also aware that they don't constitute any serious obstacle to making the Puerto Ricans' pamphlets useful to Spanish-speaking Americans elsewhere. The written language is well enough standardized to work quite well for all of them, with no more than an occasional minor inconvenience like the difference between "lift" and "elevator."

I'm also well aware that there have been many times and places in this country when school classes were taught in other languages. I still have my grandfather's fifth-grade German reader from Cincinnati. Please note, though, that he also had a comparable one in English. I have never opposed real bilingualism; in fact, I find it appalling that so many Americans never bother to acquire a working knowledge of even one other language. (I'm more or less familiar with about a dozen.) I do oppose people living in an area with one prevailing language and using only a different one. (Please note, again, that you could interchange "English" and "Spanish" throughout my essay and it would apply just as well to estadounidense expatriates living in Guatemala and expecting the Guatemalan government to give them services and information in English.)

Finally, I don't feel threatened by Spanish; I like Spanish, and it's one of the two foreign languages in which I feel most comfortable. I can't speak for others, so you may be right that some do feel so threatened. However, I suspect that if you took a closer look at some of those historic neighborhoods with foreign-language schools, they had plenty of neighbors who felt similarly threatened. That problem is called xenophobia, not Spanish. ■

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UPCOMING EVENTS Anthony Lewis

27-29 November
SILICON (California SF conference) at Santa Clara Westin Hotel, Santa Clara, Calif. Guest of Honor—Robert Jordan; Artist Guest of Honor—Richard Hescox; Fan Guest of Honor—Michelle Sagawa; TM—James P. Blaylock. Info: Silicon '92, Box 8029, San José CA 95155-8612. (408)977-0562.

27-29 November
DARKOVER GRAND COUNCIL MEETING (Annual conference on Marion Zimmer Bradley's Darkover books) at Holiday Inn, Timonium, Md. Info: Armida Council, Box 7203, Silver Spring MD 20907. (202)737-4609 (before 11:15 ET).

24-25 December
POLECON '92 (High Arctic SF conference) at The Workshop. Guest of Honor—E. Scrooge; TM—Jacob Marley. Registration—free, but limited to good little boys and girls.

15-17 January 1993
ARISIA '93 (Boston area SF conference) at Boston Park Plaza Hotel and Towers, Boston, Mass. Guest of Honor—Ellen Kushner; Artist Guests of Honor—Charles Lang & Wendy Snow-Lang; Masquerade MC—Marty Gear. Registration—$30 until 1 December, $40 at the door. Info: Arisia, Inc., Suite 322, 1 Kendall Square, Cambridge MA 02139.

2-6 September 1993
CONFRANCISCO (51st World Science Fiction Convention) at Parc 55, ANA Hotels, Moskone Centre, San Francisco, Calif. Guest of Honor—Larry Niven; Artist Guest of Honor—Alicia Austin; Fan Guests of Honor—Tom Digby and jan howard finder; MC—Guy Gavriel Kay. Registration—$85 adult/$30 child until 30 September 1992. Supporting—$25. This is the SF universe's annual get-together. Professionals and readers from all over the world will be in attendance. Talks, panels, films, fancy dress competition—the works. Join now and get to nominate and vote for the Hugo Awards and the John W. Campbell Award for Best New Writer. Info: 712 Bancroft Rd, #1993, Walnut Creek CA 94598. (510)945-1993. CompuServe 72377,3623.

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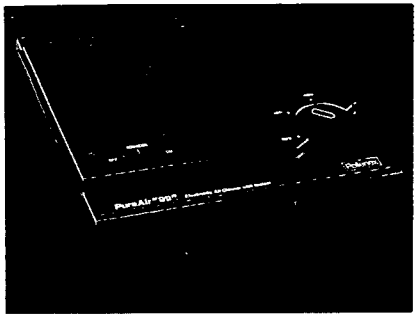
▼ FRESH AIR



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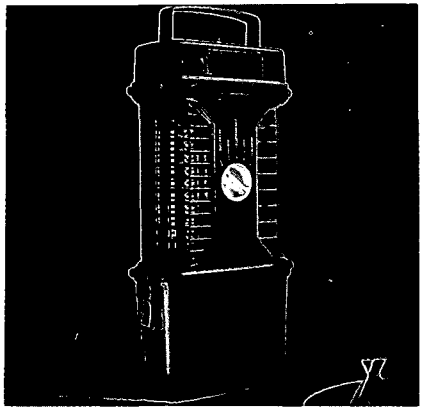
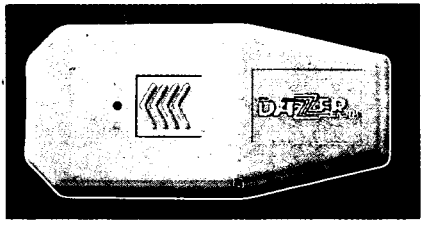


▼ THE DAZER™



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